APPENDIX D
GAS EBULLITION EVALUATION

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GAS EBULLITION EVALUATION

REMEDIAL INVESTIGATION/FEASIBILITY STUDY, NEWTOWN CREEK

Prepared by

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TABLE OF CONTENTS

List of Tables

List of Figures

LIST OF ACRONYMS AND ABBREVIATIONS

AIS	Automatic Identification System
cm	centimeter
CM	creek mile
CSO	combined sewer overflow
DGPS	differential global positioning system
DSR	Data Summary Report
MLLW	mean lower low water
NAPL	nonaqueous phase liquid
NOAA	National Oceanic and Atmospheric Administration
Phase 2 FSAP Volume 2 Addendum No. 3	*Phase 2 Field Sampling and Analysis Plan – Volume 2 Addendum No. 3*
psu	practical salinity unit
RI	Remedial Investigation
RI Report	*Remedial Investigation Report*
TEAP	terminal electron acceptor product
TOC	total organic carbon
TPAH	total polycyclic aromatic hydrocarbon (17)
TPH	total petroleum hydrocarbon
USEPA	U.S. Environmental Protection Agency

1 INTRODUCTION

1.1 Background

The Newtown Creek Remedial Investigation (RI) sampling program was conducted in Phase 1 and Phase 2 under U.S. Environmental Protection Agency (USEPA) oversight, following methods and procedures described in USEPA-approved work plans. Phase 1 sampling was conducted between October 2011 and September 2013 and was intended to broadly characterize key chemical and physical features of the Study Area[1]. Phase 2 sampling was conducted between May 2014 and December 2015 to fill data gaps and collect additional data needed to support this evaluation, as well as other RI evaluations.

Gas ebullition is the formation of gas bubbles in highly organic rich sediment due to the anaerobic decomposition of the organic material by microbes in sediment (see Section 1.3 for further description of the gas ebullition formation process). The organic material in sediment that can be considered the feedstock for gas ebullition may originate from different sources, including: naturally occurring marine vegetation and organisms; discharges of organic rich materials, including fecal material and other anthropogenic organic material from combined sewer overflows (CSOs); and other organic contaminants. Portions of the Study Area (i.e., the tributaries) are high in organic matter due to CSO inputs, and as a result have a higher potential for gas ebullition (Viana et al. 2012).

[1] The Newtown Creek Superfund Site Study Area is described in the Administrative Order on Consent (AOC) as encompassing the body of water known as Newtown Creek, situated at the border of the boroughs of Brooklyn (Kings County) and Queens (Queens County) in the City of New York and the State of New York, roughly centered at the geographic coordinates of 40° 42' 54.69" north latitude (40.715192°) and 73° 55' 50.74" west longitude (-73.930762°), having an approximate 3.8-mile reach, including Newtown Creek proper and its five branches (or tributaries) known respectively as Dutch Kills, Maspeth Creek, Whale Creek, East Branch, and English Kills, as well as the sediments below the water and the water column above the sediments, up to and including the landward edge of the shoreline, and including also any bulkheads or riprap containing the waterbody, except where no bulkhead or riprap exists, then the Study Area shall extend to the ordinary high water mark, as defined in 33 Code of Federal Regulations (CFR) §328(e) and the areal extent of the contamination from such area, but not including upland areas beyond the landward edge of the shoreline (notwithstanding that such upland areas may subsequently be identified as sources of contamination to the waterbody and its sediments or that such upland areas may be included within the scope of the Newtown Creek Superfund Site as listed pursuant to Section 105(a)(8) of Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]).

During Phase 1, the presence of nonaqueous phase liquid (NAPL) was identified at several locations in the Study Area. Phase 2 sampling was conducted to support multiple RI programs and objectives, including characterizing the presence, nature, and extent of NAPL in the Study Area (see Appendix C of the *Remedial Investigation Report* [RI Report] for the NAPL Evaluation).

Based on the preliminary findings during the NAPL Evaluation (see Appendix C of the RI Report), the need to characterize the fate and transport of NAPL, and the recommendation from the Contaminated Sediments Technical Advisory Group that gas ebullition be evaluated as a potential transport mechanism for NAPL and other hydrophobic contaminants (CSTAG 2015), the USEPA requested that the Newtown Creek Group investigate gas ebullition as a potential NAPL transport pathway as part of the Phase 2 field investigation.

Under certain environmental conditions (see Section 1.3), gas ebullition may provide a transport pathway for NAPL migration from sediment to surface water. When the buoyancy of a gas bubble is greater than the cohesive strength of the sediment, the gas bubble will rise to the water surface. If the gas bubble encounters NAPL as it rises through the sediment column, NAPL may attach to the surface of the gas bubble and be transported up to the water surface with the bubble. When the gas bubble breaks on the water surface, if NAPL is attached, it can be released, generating a hydrocarbon sheen. Through this process, gas ebullition can serve as a potential contaminant migration pathway for NAPL from sediment to surface water.

A gas ebullition field survey was performed in August 2015. The field survey was based on visual inspection of the water surface for bubbles and, to the extent allowed by the clarity of the water, observing the bubble rising through the water column to the water surface. The results of the gas ebullition field survey are presented in this appendix.

1.2 Objective

The overall objectives of this Gas Ebullition Evaluation are the following:

- Characterize the presence and extent of apparent gas ebullition based on the observation of gas bubbles in surface water in the Study Area, as well as the observation of sheen on surface water, and evaluate whether the sheen was associated with apparent gas ebullition.
- Develop an understanding of the conditions that could affect gas ebullition in the Study Area, such as temperature, water depth, and organic material sediment content and sources (e.g., CSO discharges).

This Gas Ebullition Evaluation incorporates environmental data that influence gas ebullition, including surface water temperature, tidal height, and the presence and distribution of organic content in sediment as discussed previously. The evaluation also considers potential sources of organic material in sediment to develop a preliminary understanding of the site conditions where gas ebullition is most likely to occur.

1.3 Overview of Gas Ebullition

The gas ebullition field survey approach and methods were developed to reflect what is known about environmental conditions that favor gas ebullition, and specifically, the effect of temperature, availability of organic material, and decreasing hydrostatic pressure (shallow water, particularly during low tide in tidal systems) on the rate of gas ebullition. Additional environmental data considered that influence gas ebullition to a lesser extent included weather information, vessel traffic, and other activities in the Study Area that could influence gas ebullition or field observations of apparent gas ebullition.

Gas bubbles, consisting primarily of methane, form in sediment as a result of the anaerobic microbial decay of organic matter. Once formed, these gas bubbles can migrate upward in sediment, depending on environmental conditions. Because the rate at which gas bubbles migrate upward in sediment is dependent on water temperature, overlying hydrostatic pressure, and sediment strength, gas bubble migration (gas ebullition) in a tidal system located in the northeast such as the Study Area will generally be highest during low tide conditions in the summer and early fall, when surface water and shallow sediment temperatures are the warmest.

Microbial respiration evolves generally in the following order as available terminal electron acceptor products (TEAPs) become depleted:

- Oxygen
- Nitrate
- Manganese
- Iron
- Sulfate

In this process, bacteria consume organic compounds (e.g., labile organic matter and organic contaminants, such as fecal matter discharged through CSOs) while respiring. Initially, aerobic respiration will occur until the oxygen available in the system has been depleted. After the depletion of oxygen, respiration occurs anaerobically through the use of TEAPs other than oxygen (i.e., nitrate, manganese, iron, and sulfate). This process degrades the organic compounds and ultimately produces methane and carbon dioxide as the endpoint of methanogenesis (i.e., anaerobic respiration producing methane). As shown in Figure D1-1, the methanogenic microbial decay of organic matter occurs only after more favorable aerobic and anaerobic respiration TEAPs, such as nitrate and sulfate, have been depleted.

The rate at which gas is produced by microbes in the sediment is dependent on temperature and the amount of available organic material. Less gas is produced during colder months, when the amount of microbial activity decreases; and more gas is produced during warmer months, when the amount of microbial activity increases. Research at numerous other sites shows that the majority of sediment gas production occurs during the summer months when surface water is at peak temperatures (Adriaens et al. 2009; Blischke and Olsta 2009; Chattopadhyay et al. 2010; Rockne et al. 2010; Sittoni et al. 2015; Viana et al. 2007, 2012, 2015; Yin et al. 2010).

Gas ebullition occurs when gas bubbles form in sediment and travel up to the water surface. It is dependent on the amount of gas present in the sediment, the cohesive strength of the sediment, and pressure resulting from the water depth (which changes with the tides). In order for gas bubbles to form, methane must be present in excess of the solubility limit, at which point the water becomes saturated with methane, and gas bubbles may form. As shown in Figure D1-2, salinity is also a factor and affects methane solubility by reducing the pressure and temperature at which water becomes saturated with methane.

Once a gas bubble forms, its buoyancy must overcome the cohesive strength of the surrounding sediment and the pressure of the overlying water in order to move upward through the sediment and water column to the water surface. Therefore, gas ebullition tends to be more common in soft sediment, particularly sediment with labile organic matter, in the summer months during low water conditions. In tidal systems, gas ebullition is more likely during low tide when the overlying water pressure is less.

2 GAS EBULLITION FIELD SURVEY AND DATA COLLECTION ACTIVITIES

The gas ebullition field survey was completed in accordance with the *Phase 2 Field Sampling and Analysis Plan – Volume 2 Addendum No. 3* (Phase 2 FSAP Volume 2 Addendum No. 3; Anchor QEA 2015). Data collected during the gas ebullition field survey are reported in the Phase 2 Data Summary Report (DSR; see Appendix B of the RI Report), which documents data collection methods and results, and deviations from the approved field procedures.

2.1 Survey Approach

The gas ebullition field survey was based on direct observation of bubbles on the water surface, and to the extent allowed by the clarity of the water, observation of bubbles rising through the water column to the water surface. The survey included two surveys during low tide, and one survey during high tide. Performing the surveys during low tide was based on the expectation that gas ebullition would be most active near the time of low tide, when the water pressure was lowest compared to the rest of the tidal cycle. The high tide survey was intended to evaluate the effect of increased water pressure associated with the higher water elevation on gas ebullition field survey observations. Additionally, the surveys were performed in August, when seasonal water temperatures are typically near maximum, and gas ebullition would be expected to be more active than at other times of the year, when water temperatures are lower.

During the survey, observations of apparent gas ebullition were only recorded if a bubble was seen coming to the water surface and if the bubble was not already floating at the surface. In some cases, bubbles originating from biota (e.g., crabs and fish) were observed rising through the water column. In those cases, because the source of the bubbles was apparent, the observation was recorded but not considered to be apparent gas ebullition. In areas where low water clarity limited the degree to which bubbles could be observed rising through the water column, the appearance of bubbles on the surface of the water were conservatively considered as an inferred presence of gas ebullition in sediment, unless another potential source of bubbles (e.g., boat traffic or aeration system operation) was observed nearby.

Observation and classification of sheens were included in the gas ebullition field survey because petroleum hydrocarbons and other organic compounds (e.g., decaying organic material such as leaves) may be transported from sediment to surface water via gas ebullition, forming a sheen on the surface of the water. However, sheens observed on the surface water do not always originate from gas ebullition and may be related to releases from vessels, point source discharges, or other sources. Therefore, sheens that occurred with gas bubbles and sheens that did not (e.g., from outfalls and boats) were differentiated, to the extent practical. Sheen was recorded both where it was already floating on the surface of the water and when the observation originated from a bubble coming to the surface (i.e., a sheen blossom). Field methods for documenting observations of apparent gas ebullition and sheen are described further in Sections 2.1.1 and 2.1.2, respectively.

Field surveys were performed in nine subareas, which covered approximately 70% of the Study Area (see Figure D2-1). The areas surveyed and the rationale for selecting each area for surveying are described in Section 2.1.3.

The gas ebullition field survey was performed concurrently for each of the survey areas, using multiple vessels under a range of tidal conditions. The field survey included field logging of visual observations, as well as both video and still photography of areas (provided in Appendix B the RI Report) where visual evidence of apparent gas ebullition was observed. The movements of the survey vessels over the course of the survey were tracked through the collection of continuous coordinate data. In addition, locations where visual evidence of apparent gas ebullition was observed were mapped and recorded, using differential global positioning system (DGPS) equipment.

To avoid disturbing the sediment, the surveys were performed from vessels that moved very slowly and without the use of anchors. Vessel speed did not exceed 2.5 knots in the main stem, where surface water was deeper; and it did not exceed 1 knot in areas where water was shallower and there was greater potential for the survey vessel to disturb the surface sediment. When visual evidence of apparent gas ebullition was observed, the vessel would stop and allow for detailed reconnaissance and documentation. The survey vessels did not anchor or contact the sediment surface with equipment at any time during the survey, also to avoid disturbing the sediment.

The following conditions were deemed necessary for collecting accurate observations of apparent gas ebullition:

- The survey could be performed safely without interfering with, and without interference from, vessel traffic.
- The survey had to occur during fair weather conditions.
- The survey had to occur during daytime hours to allow observation of surface water conditions.
- Survey activities could not disturb the sediment (e.g., anchoring, survey vessel movements, wakes, and propeller scour).
- Site conditions that could disturb the sediment were noted where observed (e.g., nearby spudding, construction, pile driving, sediment sampling, or other activities that could disturb bottom sediment).
- The aeration systems preferably had to be shut down a minimum of 24 hours prior to the gas ebullition field survey start date and remain shut down throughout each day that the gas ebullition field surveys were performed.

The environmental conditions during the time of the survey were documented in field logs.

2.1.1 Field Methods for Describing Observations of Apparent Gas Ebullition

The gas ebullition field survey approach was based on the visual observation of gas bubbles on the water surface, which is considered evidence of apparent gas ebullition. Gas bubbles may originate from sources other than gas ebullition; when sources of bubbles other than apparent gas ebullition were observed, this was also recorded. To characterize apparent gas ebullition, the frequency and spatial distribution of gas bubbles were recorded to allow comparison of the differences by area, and by association with low tide and high tide. Only very limited gas ebullition was observed during high tide.

When gas bubbles were observed, the frequency over a 5-minute period was quantified and then characterized as one of the following three categories:

- **Moderate-high frequency.** Bubbles are observed continuously or nearly continuously with regard to time, within the area apparent gas ebullition is observed. Areas with gas ebullition frequencies more than 100 bubbles per minute were assigned to this category.

- **Low-moderate frequency.** Bubbles appear intermittently or irregularly with regard to time, within the area apparent gas ebullition is observed. Areas with gas ebullition frequencies of more than 10 but less than 100 bubbles per minute were assigned to this category.
- **Trace-low frequency.** Bubbles appear but less frequently than low-moderate with regard to time, within the area apparent gas ebullition is observed. Areas with gas ebullition frequencies up to 10 bubbles per minute were assigned to this category.

Gas bubble density (distribution) was characterized as one of the following three categories:

- **Moderate-high distribution.** Bubbles are widespread within the area apparent gas ebullition is observed.
- **Low-moderate distribution.** Bubbles appear intermittently or irregularly within the area apparent gas ebullition is observed.
- **Trace-low distribution.** Bubbles occur only at specific, localized points within the area apparent gas ebullition is observed.

Upon review of the frequency and spatial distribution of the apparent gas ebullition, an attempt to identify the potential source was conducted, where possible.

2.1.2 Field Methods for Describing Observations of Sheen on Surface Water

When sheens were observed, distribution, structure, and color were recorded. Sheens observed with a breaking gas bubble were classified as a blossom, and the frequency of blossoms (number of blossoms over a given period of time) was noted. Sheen distributions were classified as one of five categories.

The first category describes the observation of a sheen that is observed to appear with a breaking gas bubble and is defined as follows:

- **Blossom** – observations of a sheen area (less than 3 feet in diameter) developing when a gas bubble breaks on the water surface (each individual observation of a sheen blossom was recorded)

The following four categories of sheen distribution are used to describe sheen present on the surface at the time that the field staff arrived to the survey area and **are not associated with the observation of a breaking gas bubble**:

- **Small Spots** – isolated patches (less than 3 feet in diameter) of sheen
- **Spotty** – larger areas of sheen that comprise many smaller patches (less than 3 feet in diameter) of sheen that may merge or separate over time
- **Streaks** – flat lines of sheen
- **Contiguous** – a larger patch of sheen (greater than 3 feet in diameter)

Surface sheens were agitated with a pole to determine if the observed sheen was brittle or non-brittle. If the observed sheen cracked and broke apart when disturbed, the sheen was categorized as brittle. Non-brittle sheens coalesced after disturbance.

Sheen was further described based on color, using the following terms (ASTM 2006):

- **Silvery** – metallic, near transparent to silver/gray
- **Rainbow** – multicolored
- **Dark Rainbow** – multicolored with some dark metallic or brown/black coloring
- **Dark** – dark metallic (reflects/mirrors the color of the sky) or brown/black colored

After observations of sheens not associated with blossoms had been made, an attempt to identify the potential source was conducted.

2.1.3 Selection of Survey Areas

To capture the range of geomorphic, hydrologic, and hydrodynamic conditions in the Study Area, the criteria for the selection of the gas ebullition field survey areas included the following:

- Surveying various geomorphic settings, including the tributaries, the main stem of Newtown Creek, and creek mile (CM) 2+
- Capturing the range of water depths present in the Newtown Creek system to assess the effect of water depth (i.e., hydrostatic pressure) on gas ebullition
- Proximity of the area to organic material sources

- Vessel traffic frequency to assess the effect of propeller wash and vessel wake on disturbance of sediment and appearance of gas bubbles in surface water
- Surveying areas with a range of NAPL observations in the sediment
- Surveying areas where anecdotal (i.e., not characterized in detail or quantified) observations of gas bubbles had been previously reported
- Avoiding areas near active aeration systems to avoid misidentification of bubbles associated with the aeration systems as apparent gas ebullition

The selection criteria above led to the identification of the following nine survey areas:

- Newtown Creek, from CM 0.19 to 0.5, CM 0.67 to 0.83, CM 0.9 to 1.36, and CM 1.6 to 1.94
- Dutch Kills
- Maspeth Creek
- Turning Basin
- East Branch
- English Kills (with the goal to conduct the survey when the aeration system was not operating)

The survey areas covered approximately 120 acres (70% of the total Study Area) and captured a wide range of conditions. Water depths in the survey areas ranged from less than 5 feet mean lower low water (MLLW) to 20-plus feet MLLW. During low tide, portions of Maspeth Creek have exposed mudflats. Survey areas included tributary heads that receive organic material in the form of CSOs, as well as areas with less organic material input. In addition, portions of the main stem, Turning Basin, and English Kills that experience regular vessel traffic were evaluated. Five vessels with observers were used to perform each survey.

The survey also covered areas with and without NAPL present in the underlying sediment, including NAPL present at a range of depths and magnitude. See Appendix C of the RI Report for a detailed discussion of potential NAPL observations and shake test results.

Table D2-1 summarizes the environmental conditions present within each survey area and which vessel was used to make observations of the survey areas. The survey areas are shown in Figure D2-1.

2.1.4 Survey Timing

As previously described, sediment gas production is sensitive to both temperature and hydrostatic pressure.

The gas ebullition field survey was performed at a time when Study Area surface water was at its peak yearly temperature (gas ebullition was most likely to occur). Environmental conditions during the gas ebullition field survey included near-maximum seasonal water temperature (when gas ebullition would be expected to be highest) and low tide water levels/low hydrostatic pressure. Research at other sites indicates that gas ebullition activity drops significantly with seasonal decreases in temperature, typically when surface water temperatures fall below 10° to 20° C (Adriaens et al. 2009; Blischke and Olsta 2009; Chattopadhyay et al. 2010; Rockne et al. 2010; Sittoni et al. 2015; Viana et al. 2007, 2012, 2015; Yin et al. 2010).

Surveys were performed for one high tide and two low tides to evaluate the sensitivity of hydrostatic pressure on occurrences of gas ebullition in the Study Area. The first survey was performed during high tide on the afternoon of August 18, 2015. The second and third gas ebullition field surveys were performed during low tide the evening of August 18, 2015, and low tide the morning of August 19, 2015. The start and end times for each survey, as well as the time of low tide and the tidal elevations at the time of the surveys, are summarized in Table D2-2 and are displayed in Figure D2-2.

Although the gas ebullition process is sensitive to many factors (see Section 1.3), the two key factors considered while selecting the timing of the survey were temperature and tidal elevations. Low Tide Survey No. 2 was performed when the surface water was 24° C and at an elevation of 0.52 foot MLLW. This represents the 94th percentile of conditions. Only 5.5% (39/705) of 2015 low tides met both of the following conditions:

- Equivalent or warmer surface water temperatures (greater than or equal to 24° C) than those observed during the gas ebullition field survey
- Equivalent or lower low tide elevations (less than or equal to 0.52 foot MLLW) than those surveyed during the gas ebullition field survey

In 2015, 33% (233/705) of low tide events met both of the following conditions:

- Surface water temperatures in excess of 15° C, the temperature above which research shows gas ebullition is most active
- Lower low tide elevations (less than 0.52 foot MLLW) than those surveyed during the gas ebullition field survey

Table D2-3 summarizes the types of data collected during the gas ebullition field survey.

2.2 Data Collection

During each survey where visual evidence of apparent gas ebullition or sheen was observed, the following information was recorded: observation ID and its global positioning system coordinates, type of observation on the surface water (apparent gas ebullition, sheen, coincident gas ebullition and sheen), approximate size of the area, a video and/or still photographs showing the cycle of bubble formation and coincident gas bubble/sheen observations (if applicable), and a qualitative assessment of bubble frequency using the terminology included in the Phase 2 FSAP Volume 2 Addendum No. 3 (Anchor QEA 2015) and provided in Section 2.1.1. If sheens were observed, the approximate frequency, approximate dimension, visual appearance (e.g., silvery, rainbow, dark rainbow, or dark), structure (e.g., brittle or non-brittle), and distribution (e.g., blossom, small spots, spotty, streaks, or contiguous) were documented as described in Section 2.1.2.

In addition to the apparent gas ebullition and sheen observations, nearby activities were noted that could potentially create false indications of gas ebullition by disturbing the sediment (i.e., vessel movements, wakes, and propeller scour; anchoring; spudding; pile driving; construction; sediment sampling; other activities that could disturb bottom sediment; and active aeration systems that generate gas bubbles). In addition, the generation of bubbles by biota was noted. In English Kills, the operating status of the aeration system was recorded and the location of the bubbles apparently originating from the aeration system was mapped relative to survey observations/measurements.

At each apparent gas ebullition observation location, a surface water quality measurement (i.e., water temperature and salinity within 3 feet of the sediment surface and water clarity) was collected. If turbidity was observed in surface water as a result of vessel passage, or if other discharges to surface water resulted in turbidity, a Secchi disk measurement was taken.

2.2.1 Sample Station Locations

Gas ebullition field survey station horizontal positioning during sample collection was determined by a DGPS based on target coordinates for each station. Positions collected by the DGPS were differentially corrected using the nearest available National Oceanic and Atmospheric Administration (NOAA) base station and reported in North American Datum of 1983, New York Long Island, State Plane feet. Measured geographical coordinates for station positions were recorded and reported to a precision of the nearest tenth of a foot. The DGPS accuracy is less than 1 meter, and generally less than 30 centimeters (cm), depending upon satellite coverage. In addition, survey vessel movements were tracked by collecting continuous DGPS position coordinates to document survey vessel transects. If DGPS was unavailable, survey staff hand-recorded vessel movements on survey area maps using dead reckoning based on the shoreline and in-water landmarks, which are included in the field forms in Appendix B, Attachment B-C11. The water depth was measured using the vessel echo-sounder upon arrival at the station when available, or was estimated from the tidal stage.

2.2.2 Surface Water Quality Monitoring

Prior to the start of each survey, field measurements, including surface water temperature, salinity, and water clarity measurements, were recorded using a sonde and Secchi disk at the 19 locations within the Study Area shown in Figure D2-3. At least one water quality station was present within each gas ebullition field survey area.

In addition, surface water monitoring of water temperature and salinity was conducted within 3 feet of the sediment surface in areas where apparent gas ebullition was observed.

After each survey was completed for an area, post-survey water quality measurements were collected and the water depth was measured using a lead line at each surface water quality monitoring location. Lead line water depth measurements were collected after the surveys were completed to avoid potentially influencing apparent gas ebullition observations by disturbing the sediment.

2.2.3 Other Environmental Data

General weather, water surface, and the time of the nearest high or low tide were recorded at the beginning of each survey, and changes in conditions were documented with each observation of gas bubbles or sheen. Tidal elevations were observed from nearby tidal gauges. Atmospheric temperature and pressure were recorded from the weather station located at the Greenpoint Energy Center (DAR No. 32), at the beginning and end of each survey.

3 SURVEY RESULTS

This section presents the results of the gas ebullition field survey, including a summary of the apparent gas ebullition observations, sheen observations, surface water quality measurements, vessel activity throughout the Study Area, and tide and weather conditions, as outlined in Section 2.

3.1 Survey Transects

Figures D3-1a through D3-1c present the survey vessel transects for the three survey events. Vessel transects show that surveying was performed in all the target areas identified in the Phase 2 FSAP Volume 2 Addendum No. 3 (Anchor QEA 2015).

Survey areas did not include areas within approximately 100 feet of operating aeration systems. During High Tide Survey No. 1 and Low Tide Survey No. 1, the aeration system in both upper and lower English Kills was operating. During Low Tide Survey No. 2, the aeration system in lower English Kills was not operating, so comparatively more of the tributary was surveyed during Low Tide Survey No. 2 compared to High Tide Survey No. 1 and Low Tide Survey No. 1. English Kills shoreline areas (i.e., areas located more than 100 feet from the operating aeration system) were surveyed during all three survey events.

3.2 Survey Results

Observations of apparent gas ebullition and surface water sheen during the gas ebullition field survey are discussed in Sections 3.2.1 and 3.2.2, respectively. Actual survey locations, survey collection dates, water depths, and survey observations are summarized in Table D3-1 (gas bubble observations) and Table D3-2 (sheen observations).

3.2.1 Gas Bubble Observations

Over the course of the three individual surveys, 45 observations of gas bubbles were recorded. Gas bubbles were observed in the main stem of the creek[2] (from CM 0.9 to 1.36 and CM 1.6 to 1.94), in each of the tributary survey areas, and the Turning Basin. Gas

[2] The term "creek" is used interchangeably with "Study Area" throughout this Gas Ebullition Evaluation.

bubbles were not observed in the main stem survey areas CM 0.19 to 0.50 and CM 0.67 to 0.83 during any of the three survey events. Table D3-1 summarizes all observations of gas bubbles, including the location, date, and time of the observation, as well as the frequency of bubbles and the bubble source, if possible.

Not all gas bubble observations (8 out of 45 observations) recorded during the surveys were the result of apparent gas ebullition. Gas bubbles were observed on the water surface in proximity to an operating aeration system in English Kills; because the bubbles were observed to be already on the water surface and not rising through the water column, the bubble source was inferred to be from the nearby operating aeration system. Gas bubbles associated with biota were also observed. In these instances, the source of the bubbles, such as fish or crabs, could be observed beneath the water surface producing gas bubbles. In summary, three observations of gas bubbles were attributed to the operation of aeration systems in English Kills and not believed to be evidence of gas ebullition. Five observations of gas bubbles were attributed to the presence of biota and not believed to be evidence of apparent gas ebullition.

As indicated in Table D3-1, the remaining 37 bubble observations from the three survey events are inferred to be or attributed to apparent gas ebullition.

Gas bubble observations include the following three elements:

- Spatial extent of gas bubbles (i.e., the area over which gas bubbles were observed)
- Frequency at which gas bubbles were observed
- Spatial distribution of gas bubbles within the area where the gas bubbles were observed

Figures D3-2a through D3-2c show the spatial extent of apparent gas ebullition observations for each survey by gas bubble frequency. Where gas bubbles were observed, the boundaries of the area were mapped, and the frequency that gas bubbles were observed within the mapped area over a 5-minute period was quantified and then characterized accordingly as either moderate-high frequency, low-moderate frequency, or trace-low frequency (see Section 2.1.1 for more details).

Figures D3-3a through D3-3c show the spatial extent of apparent gas ebullition observations for each survey by the spatial distribution of gas bubbles. In this case, spatial distribution describes the observed distribution of gas bubble observations (i.e., moderate-high distribution) or localized (i.e., trace-low distribution) within the area where the gas bubbles are observed. The spatial distribution of the gas bubbles was categorized accordingly as either moderate-high distribution, low-moderate distribution, or trace-low distribution (see Section 2.1.1 for more details).

Figure D3-4 shows representative photographs of gas bubbles on the water surface that were interpreted to represent apparent gas ebullition.

Apparent gas ebullition was infrequent during the high tide event compared to the low tide events and was only observed in Dutch Kills (two locations) and East Branch (one location). More than 90% of the observations of apparent gas ebullition occurred during the two low tide surveys. There were 13 locations with gas bubbles observed during Low Tide Survey No. 1 and 21 locations with gas bubbles observed during Low Tide Survey No. 2, which were interpreted to represent apparent gas ebullition (see Table D3-1).

In general, the extent and distribution of apparent gas ebullition in the tributaries was greater than in the main stem, where apparent gas ebullition observations (when observed) were generally localized (with a trace-low distribution). The largest areas of apparent gas ebullition were observed in Dutch Kills, Maspeth Creek, East Branch, and the Turning Basin during the low tide surveys. The extent, frequency, and distribution of apparent gas ebullition appear to correspond to the tidal cycle, with more apparent gas ebullition observed during low tide, as expected by the physics driving the gas ebullition process (see Section 1.3).

3.2.1.1 High Tide Survey

High tide survey observations of apparent gas ebullition were limited to the heads of Dutch Kills and East Branch; these observations were located immediately adjacent to the CSOs located at the head of each tributary in these areas. Apparent gas ebullition observations during the high tide survey were limited in size to areas of less than 3,000 square feet, were trace-low to low-moderate in frequency (see Figure D3-2a), and were trace-low to moderate-high in spatial distribution (see Figure D3-3a).

3.2.1.2 Low Tide Survey No. 1

During the first low tide survey, apparent gas ebullition was predominately observed at the heads of Maspeth Creek, East Branch, and English Kills, where widespread apparent gas ebullition was observed (see Figure D3-3b). Apparent gas ebullition frequencies were typically between 30 and 60 bubbles per minute (see Figure D3-2b). A small, localized (i.e., trace-low spatial distribution) observation of apparent gas ebullition at CM 1.7 had one of the highest bubble frequencies observed during the gas ebullition field survey of 199 bubbles per minute.

3.2.1.3 Low Tide Survey No. 2

Compared to the first low tide survey (low tide of 0.67 foot MLLW), occurrences of apparent gas ebullition observations in Dutch Kills, Maspeth Creek, and English Kills were more widespread during the second low tide survey (low tide of 0.52 foot MLLW), both in spatial extent and distribution (see Figure D3-3c). Additionally, the frequency at which gas bubbles were observed in Dutch Kills and English Kills was higher during the second low tide survey, where more than 100 bubbles per minute in some locations were observed (see Figure D3-2c). These were among the highest bubble frequencies observed during the gas ebullition field survey and were generally observed in areas where the gas bubbles were observed to have moderate-high spatial distribution across the area over which they were observed.

During the second low tide survey, apparent gas ebullition was observed in an extensive portion of the Turning Basin. The gas bubbles in the Turning Basin had a trace-low frequency and trace-low spatial distribution.

In summary, the apparent gas ebullition appears to correlate with the tides and increases with the associated reduction in hydrostatic pressure experienced by the sediment during low tide events.

3.2.2 Sheen Observations

Sheen was observed in all survey areas for a total of 53 individual observations of sheen over the three surveys. Table D3-2 summarizes sheen observations, including the location, date, and time of the observation, as well as the distribution of the sheen, sheen properties, and interpreted sheen source.

The majority of sheen was observed during the high tide survey and the second low tide survey (see Table D3-2). During the high tide survey, sheen was predominantly observed in Dutch Kills and East Branch. During the first low tide survey, the majority of sheen observed was located in East Branch. During the second low tide survey, sheen was observed throughout all survey areas, with the largest area of sheen observed in the Turning Basin.

Figures D3-5a through D3-5c show the areas where sheen was observed for each survey by sheen distribution. Figures D3-6a through D3-6c show the areas where sheen was observed for each survey by sheen structure and color. Figure D3-7 shows representative photographs of sheens on the water surface.

When a sheen was noted during the surveys, an effort was made to identify a potential sheen source. For more than half of the sheen observations (31 out of 53), the source was unknown (see Table D3-2). For 18 of the remaining 22 observations of sheen, a potential source was identified (see Table D3-2), which is summarized as follows:

- In 14 instances, sheen was found in the same area as floatables and surface scum.
- During the Low Tide Survey No. 2 in English Kills, sheen was observed coincident with vessel movement in four locations.

In these instances, although sheen was observed coincident with a potential anthropogenic source, none of these potential sources was directly observed to be releasing sheen. Therefore, these observations are considered circumstantial and not confirmation of a source.

In four instances, sheen blossoms were observed. Sheen blossoms (i.e., sheens were observed to appear on the water surface associated with breaking gas bubbles) were observed only at the head of English Kills and in the Turning Basin during the low tide surveys (see Table

D3-2). A compilation of the locations where sheen blossoms were observed during the gas ebullition field survey are shown in Figure D3-8. Sheen blossoms were observed in one location at the head of English Kills only during Low Tide Survey No. 1 and were adjacent to timber piles. Turning Basin sheen blossoms were observed in three locations, only during Low Tide Survey No. 2. No sheen blossoms were observed during High Tide Survey No. 1.

The majority of sheen observations (35 out of 53) were slight, consisting of small spots or spotty sheens.

Unlike the apparent gas ebullition observations, the distribution of sheens did not correspond to tidal cycle. For High Tide Survey No. 1 and Low Tide Survey No. 1, larger sheens were observed in the tributaries, more so than in the main stem. For Low Tide Survey No. 2, larger sheens were observed in the Turning Basin, more so than in the tributaries.

3.2.2.1 High Tide Survey

During the high tide survey, 21 observations of sheen were recorded. Most sheen observations consisted of isolated patches of sheen or groups of small patches of sheen less than 3 feet in diameter. Only two observations during high tide were streaks (English Kills) or contiguous (CM 1.60 to 1.94). Sheens at high tide were silvery or rainbow in color, where the silvery observations were brittle and non-brittle, and the rainbow sheens were brittle (see Table D3-2). The largest areas of sheen were found in Dutch Kills and East Branch (see Figures D3-5a and D3-6a).

Sheen blossoms were not observed during the high tide survey.

3.2.2.2 Low Tide Survey No. 1

During the first low tide survey, nine observations of sheen were recorded. Small spots of sheen were observed in Dutch Kills, whereas streaks of sheen were found throughout East Branch, and one small area was observed in CM 1.60 to 1.94 (see Figure D3-5b). Sheen during the afternoon low tide event was either silvery or rainbow (see Figure D3-6b). The silvery sheen was primarily non-brittle, but there were two occurrences of brittle, silvery sheen. The rainbow sheen was non-brittle. The most extensive areas of sheen were found in the East Branch, and sheen observations in other survey areas during the first low tide were small in comparison.

A sheen blossom was observed in the head of English Kills. The sheen blossom was observed in a discrete area (approximately 740 square feet) located adjacent to a timber bulkhead, with a frequency of one blossom per minute.

3.2.2.3 Low Tide Survey No. 2

During the second low tide survey, 23 observations of sheen were recorded. Sheen was observed in all survey areas. The largest areas of sheen were observed in the Turning Basin where spotty streaks, streaks, and blossoms were found (see Figure D3-5c). Small spots, spotty, and contiguous sheens were observed in English Kills. Maspeth Creek had contiguous sheen adjacent to the boom, and there were sheen streaks at the head of East Branch. The sheen present in the main stem was typically small spots or spotty. Silvery sheen was predominantly found from CM 0.19 to 1.94 (see Figure D3-6c).

Sheen blossoms were observed in three areas in the Turning Basin (see Figures D3-5c and D3-6c). Sheen blossoms were observed at a frequency of approximately one blossom per 5 minutes. The apparent gas ebullition rates in the three areas where the sheen blossoms were observed varied from 5 to 35 bubbles per minute. The size of each of the sheen blossom areas was approximately 50 square feet, totaling 150 square feet.

3.3 Surface Water Quality Data

Tables D3-3a through D3-3c summarize the surface water quality measurements made before, during, and after each of the three surveys. Actual surface water profiling locations are shown in Figures D3-1a through D3-1c. Surface water quality data were collected at these stations approximately 3 feet above the mudline before, during, and after the surveys. As shown in Figure D3-9, surface water temperature, salinity, and clarity were generally consistent between surveys.

Variable surface water temperature and salinity was observed between the main stem and tributaries. In the tributaries, water temperature ranged from 23.1° to 27.1° C, and salinity ranged from 20.7 to 23.9 practical salinity units (psu). In the main stem, water temperature ranged from 24.1 to 26.3° C, and salinity ranged from 22.6 to 24.9 psu.

During the gas ebullition field survey, the daily average measured water temperature at NOAA's The Battery Station was 25° C (NOAA 2016a). In 2015, the arithmetic average of the daily average measured water temperature at NOAA's The Battery Station was 14° C, with measured temperatures ranging between 0 and 25° C (NOAA 2016a), indicating that the gas ebullition field survey was performed during the period of peak annual surface water temperature.

Water clarity (measured using a Secchi disk) varied but was generally sufficient to observe bubbles rising through the water column (versus migrating from other sources) and identify sources other than apparent gas ebullition for gas bubbles. This degree of water clarity indicates minimal creek bottom disturbance during the survey period, and that observations of apparent gas ebullition were not due to bottom disturbance from surveying activities.

The relatively small variability (compared to seasonal ranges) in water quality measurements indicates that water quality did not affect survey observations and was not likely a factor influencing apparent gas ebullition.

3.4 Other Environmental Data

Environmental and anthropogenic conditions have the potential to affect apparent gas ebullition observations or be a false indicator of gas ebullition. Environmental factors that could have an effect on gas ebullition include air temperature, barometric pressure, wind speed, and wind direction, or the presence of biota. Anthropogenic factors of concern for the Study Area included vessel movements, wakes, and propeller scour; anchoring; spudding; pile driving; construction; sediment sampling; and other activities that could disturb the bottom sediment. An additional anthropogenic factor was the aeration systems present, which if operating, could obscure observations of apparent gas ebullition and sheen and are a source of bubbles on the surface water.

The aeration systems in English Kills were active during the high tide and first low tide surveys but were inactive during the second low tide survey. Therefore, the observation of gas bubbles in English Kills was not solely due to apparent gas ebullition but at times was a result of the aeration system. These instances were noted.

3.4.1 Tidal Elevations

During the gas ebullition field survey, the predicted high tide water surface elevation at the NOAA Hunters Point, Newtown Creek Station was 4.24 feet MLLW, and the water surface elevations for Low Tide Surveys No. 1 and No. 2 were 0.67 and 0.52 foot MLLW, respectively. Head differences, or the difference in water surface elevation between high and low tide, ranged from 2.4 to 6.3 feet in 2015, with an arithmetic average of 4.2 feet. The gas ebullition field survey had a tidal elevation difference of 3.6 feet, which is 0.6 foot below the arithmetic average. This tidal difference represents the 27th percentile for 2015 yearly tidal differences (with the 100th percentile representing the largest difference between low and high tide that occurred in 2015) as shown in Figure D3-10.

3.4.2 Weather Conditions

During the three surveys, the environmental conditions were similar, with a slight breeze and either sunny or cloudy (see Table D3-4). Little wave action was observed, and the water was typically calm. There was slight wave action in a few locations, but the wave height did not exceed 0.3 foot from crest to trough.

There was little variability in the weather conditions from High Tide Survey No. 1 to those observed during the two low tide surveys (see Table D3-5). The arithmetic average air temperature ranged from 26 to 31° C and the arithmetic average barometric pressure was approximately 30 inches of mercury. Wind speed fluctuated over the survey period but was minimal, and had an arithmetic average between 4.5 and 9.5 miles per hour. Therefore, due to the calm weather conditions (see Figure D3-11), it does not appear that weather conditions influenced survey observations or gas ebullition.

3.4.3 Vessel Traffic

According to Automatic Identification System (AIS) data (available from marinetraffic.com, publically available for vessels equipped with and operating AIS systems), there was minimal vessel traffic during the surveys. AIS data show vessel movement in survey areas CM 0.19 to 0.50, CM 0.67 to 0.83, and CM 0.90 to 1.36 (see Figures D3-12a and D3-12b). Vessel traffic observed during the survey periods was also noted.

Idling vessels were observed in English Kills, close to the Metropolitan Bridge, during Low Tide Survey No. 1.

A parked barge was observed in English Kills during the two low tide surveys. During Low Tide Survey No. 2, a sheen was observed around the barge. At the time of the sheen observation, the barge was being loaded with scrap metal. Other than the sheen observation around this barge, vessel movements were limited and did not likely influence survey observations.

4 EVALUATION AND INTERPRETATION

Section 4 includes the following evaluation and interpretation of survey results:

- The survey results are summarized.
- The representativeness of the survey is evaluated by assessing potential differences in gas ebullition at other times of the year (based on environmental conditions that differ from the environmental conditions during the survey) compared to gas ebullition observed during the survey.
- The survey results are interpreted using different lines of evidence that might affect gas ebullition.
- Observations of NAPL in the top 5 feet of sediment were compared to gas ebullition field survey results to assess possible connections between NAPL and gas ebullition field survey observations of sheen blossoms.

4.1 Summary of Survey Results

A rigorous gas ebullition field survey approach was developed based on the observation of gas bubbles and surface water sheens, measurement or observation of environmental conditions, and noting anthropogenic factors that could influence the observations of gas bubbles and sheen. The survey was conducted in mid-August during peak seasonal water temperatures when gas ebullition is expected to be most active, so it is likely a conservative record of observations of apparent gas ebullition. The surveys covered a wide range of environmental conditions in nine areas, totaling approximately 120 acres and covering approximately 70% of the Study Area.

Three separate surveys were performed, one at high tide and two at low tide, to assess the effect of changing water depth (pressure) on apparent gas ebullition. Weather and water quality data were collected before, during, and after surveys to evaluate the potential effects of environmental conditions on apparent gas ebullition and survey observations. Performance standards were used during the field surveys to minimize the potential for survey activities to disturb the sediment bed and induce gas bubbles. Finally, the surveys were conducted during fair weather conditions when apparent gas ebullition and sheens would be most visible.

Apparent gas ebullition was observed throughout the survey area. The largest areas of apparent gas ebullition were observed in the Dutch Kills and East Branch tributaries and in the Turning Basin. Gas bubbles generally occurred at a moderate-high frequency and spatial distribution in the tributaries (Dutch Kills, English Kills, and East Branch) and at trace-low frequency and spatial distribution in the main stem areas.

Apparent gas ebullition was observed in more areas, at higher frequencies, and with greater spatial distribution during Low Tide Survey No. 2 than in Low Tide Survey No. 1 or High Tide Survey No. 1.

Sheens were also observed throughout the survey areas. Unlike observations of apparent gas ebullition (e.g., bubbles), the distribution of sheens did not correspond to tides and varied between surveys with regard to tributary and main stem locations.

The primary findings of the survey included the following:

- Sheens that originated from gas bubbles (sheen blossoms) were observed only in the following two locations:
  - Low Tide Survey No. 1, near the head of English Kills, adjacent to a timber bulkhead, at a rate of one sheen blossom per minute
  - Low Tide Survey No. 2, in the Turning Basin, in three areas, at a rate of one sheen blossom every 5 minutes in each area
- Sheen blossoms were not observed during High Tide Survey No. 1.
- No consistent relationship was observed between apparent gas ebullition and surface water sheen observations.
- Apparent gas ebullition alone (i.e., without sheen blossoms) is more widespread in the tributaries, likely due to combined CSO loads of organic material to tributary sediment and shallower water, when compared to the main stem.

Observations of sheen blossoms were limited to localized areas in English Kills and the Turning Basin. Note that the sheen blossom in English Kills likely did not originate from sediment (no NAPL was observed in sediment at this location) but may have been associated with creosote-treated timber piles along the shoreline (California Coastal Commission 2012).

4.2 Evaluation of the Representativeness of the Gas Ebullition Field Survey Results

This section evaluates the representativeness of the environmental conditions during the gas ebullition field survey. In this context, the term "representativeness" refers to the comparison of the environmental conditions that influence gas ebullition (primarily tidal cycle and water depth and water temperature) during the surveys, to those environmental conditions that occur during other times of the year.

To complete the representativeness evaluation, a typical annual range of Study Area environmental conditions was compared to the environmental conditions during the gas ebullition field survey.

Factors favorable for gas ebullition include shallow water/low hydrostatic pressure, warm sediment temperatures, and sediment that is cohesive with low permeability and high organic material content. Tidal elevation, surface water temperature, and sediment organic material content data were reviewed to identify the environmental conditions and locations in the Study Area most favorable for gas ebullition.

4.2.1 Hydrostatic Pressure and Tidal Elevations

In general, gas ebullition is more likely in shallower portions of the Study Area during low tide (in particular during lunar low tides) and when hydrostatic pressure is lowest.

As shown in Figure D4-1, creek depths are the shallowest in Maspeth Creek, Dutch Kills, East Branch, and the head of English Kills, averaging -7.6 feet MLLW. The main stem has depths ranging from -27.7 to 4.4 feet MLLW, with the deepest areas found from CM 0.9 to 1.

Low tide elevations surveyed during the gas ebullition evaluation were compared to the range of low tide elevations that occurred in 2015. The range of low tide elevations for 2015 was between -1.2 and 1.2 feet MLLW, with an arithmetic average low tide elevation of 0.11 foot MLLW (NOAA 2016b; see Figure D4-2). Low tide elevations during the gas ebullition field survey were 0.56 and 0.41 foot above the arithmetic average. With the 100th percentile representing the lowest low tide surface water elevation that occurred in 2015, the two low tide elevations surveyed during the gas ebullition field survey represent the 14th and 21st percentile.

As described in Section 2.1.4, gas ebullition generally becomes active when water temperatures exceed 15° C. There were 233 low tides in 2015 (out of a total of 705) that had temperatures in excess of 15° C and lower water elevations than were present for the gas ebullition field survey. Environmental conditions for gas ebullition during these 233 low tide events could potentially be favorable for gas ebullition but are not directly comparable to gas ebullition field survey conditions, primarily because of near maximum water temperature during the survey that significantly exceeded the 15° C benchmark used in this evaluation (see Section 4.2.2).

Apparent gas ebullition was observed in tributaries for all tidal events. During the high tide event, apparent gas ebullition was observed at the head of Dutch Kills and East Branch. As the water depths decreased in the time leading up to low tide, the extent of apparent gas ebullition in the tributaries tended to increase. Depths during Low Tide Event No. 2 were the lowest during the survey period, and not only was apparent gas ebullition observed throughout the tributaries, it was present in deeper areas, such as the Turning Basin and lower English Kills.

4.2.2 Surface Water Temperature

The degree that gas ebullition occurs is expected to peak in the summer when sediment temperatures are highest and decrease to nearly no occurrence in the winter, when lower temperatures result in less microbial activity. The range of surface water temperatures collected from NOAA's The Battery Station in 2015 was from -0.9 to 25° C, with an arithmetic average surface water temperature of 13° C (NOAA 2016a). The arithmetic average daily surface water temperature during the gas ebullition field survey was 24° C, which represents the 92nd percentile of surface water temperatures for 2015 (see Figure D4-3). Surface water temperatures at the time of the survey were more favorable for gas ebullition than the large majority of low tides in 2015.

4.2.3 Interpretation of the Gas Ebullition Field Survey Relative to Annual Study Area Environmental Conditions

Low tide water surface elevations during the gas ebullition field survey were higher than 79% of low tide events in 2015. However, when combined with annual surface water temperatures, the gas ebullition field survey was performed under conditions that were conducive to gas ebullition, as shown in Figure D4-4. These conditions represent the 94th percentile of combined annual surface water temperatures and low tide surface water elevations for the Study Area (assuming surface water temperatures greater than or equal to 24° C and tidal elevations greater than or equal to 0.52 foot MLLW). One unknown for the Study Area is the relative influence of temperature versus hydrostatic pressure on gas ebullition. Results of this analysis will vary if one factor predominates over the other.

In addition, by including the full length of each of the tributaries in the surveys, the gas ebullition field survey included portions of the creek with the shallowest water and highest organic carbon concentrations, where gas ebullition is most likely to occur. Based on the review of Study Area environmental conditions, the gas ebullition field survey was performed at a time when conditions for gas ebullition were more favorable than during the majority of the year, and the portions of the Study Area where environmental conditions are most favorable for gas ebullition were surveyed.

4.3 Additional Lines of Evidence Used in the Gas Ebullition Evaluation

The potential gas ebullition NAPL to surface water migration pathway was evaluated based on the gas ebullition field survey observations, supported by evaluation of additional lines of evidence.

Sediment organic material inputs, physical data, sediment NAPL, and surface water chemistry were evaluated. Supplemental datasets include sediment total organic carbon (TOC) concentrations, sediment NAPL observations, chemical concentrations for surface water, and descriptions of the physical characteristics of the Study Area (e.g., bathymetry and locations of CSOs and outfalls). The supplemental datasets compiled are described in more detail in the following subsections.

Consistent with the Gas Ebullition Evaluation objectives, the lines of evidence evaluation considers gas ebullition generally in Newtown Creek. However, it should be noted that observations of sheen blossoms (i.e., potential indicators of gas ebullition and NAPL transport) were limited in areal extent and frequency. As described in Section 4.1, observations of sheen blossoms were limited to three discrete locations in the Turning Basin during Low Tide Survey No. 2, and one location in English Kills (that may have been influenced by proximity to shoreline structures) during Low Tide Survey No. 1.

4.3.1 Sediment Organic Material Inputs

As discussed in Section 1.3, anaerobic decomposition of organic material in sediment results in methanogenesis. When the partial pressure of methane in sediment porewater exceeds the hydrostatic pressure, methane bubbles are generated. Therefore, gas ebullition is fundamentally dependent on the amount of readily biodegradable organic material deposited on the sediment bed. Organic carbon concentrations in sediment are indicators of organic material inputs to sediment. Surface and subsurface bulk sediment samples were collected as part of various RI investigation programs for TOC analysis.

The maximum TOC concentrations measured in each core in the top 152 cm (5 feet) of the sediment bed are shown in Figure D4-5. The highest maximum TOC levels were detected in the tributaries and portions of the Turning Basin. Lower TOC concentrations were present in the main stem of Newtown Creek when compared to the tributaries.

CSOs are sources of organic material, and literature (Viana et al. 2012) shows that the highest rates of gas ebullition for sites with CSOs are generally observed in sediment closest to the CSO discharge. As shown in Figure D4-6, CSOs are located throughout Dutch Kills; the heads of Maspeth Creek, East Branch, and English Kills; the downstream portion of the main stem from the mouth to CM 1.35; and the lower portion of the Turning Basin. Annual CSO discharge flows are discussed in Section 2 of Appendix E to the RI Report and relative contributions of point source discharges, including CSOs, are summarized in Figure E2-5. The largest discharges occur from CSOs located at the head of East Branch (NCB-083), the head of English Kills (NCB-015), the head of Maspeth Creek (NCQ-077), and the head of

Dutch Kills (BB-026). Figure E2-2 of Appendix E shows the locations and IDs of point source discharges to the Study Area.

Apparent gas ebullition was observed in the vicinity of CSOs during all three surveys. The two occurrences of apparent gas ebullition observed during the high tide event were in the vicinity of CSOs in Dutch Kills and East Branch. During Low Tide Event No. 1, apparent gas ebullition was also observed in the vicinity of CSOs in the tributaries. During Low Tide Event No. 2, apparent gas ebullition was observed adjacent to CSOs in Dutch Kills, Maspeth Creek, East Branch, and the Turning Basin. Small areas (approximately 300 square feet) of apparent gas ebullition were also observed in the vicinity of a CSO in the main stem of Newtown Creek at CM 1.33. In general, apparent gas ebullition was more extensive and of a higher frequency in the tributaries than in the main stem, consistent with higher organic matter inputs from CSOs to the tributaries.

It is important to note that apparent gas ebullition observed in the tributaries, with the exception of one discrete location in English Kills that may have been influenced by proximity to timber shoreline structures, did not have sheen blossoms observed with the apparent gas ebullition (i.e., only gas bubbles were observed).

4.3.2 Physical Data

Physical data include physical characteristics of the Study Area, including the following:

- Bathymetry (water depth)
- CSOs and other outfalls, which represent potential sources for NAPL and other materials with high TOC concentrations
- Shoreline structures (e.g., timber piles)
- Booms

Water column depth for the Study Area is shown in Figure D4-1. Shallower water depths (typically less than 20 feet) provide an environment that can be favorable for gas ebullition. This is generally consistent with survey observations. Gas ebullition was generally more extensive in the shallow tributaries than in the deeper main stem areas. Additionally, apparent gas ebullition was more extensive during the low tide surveys than the high tide survey.

The Phase 1 and Phase 2 investigations included numerous surveys conducted to characterize the shoreline surrounding the Study Area and to document the presence of outfalls that discharge to the Study Area. Data collected during Phase 1 were included in three DSRs that were submitted to USEPA in January, April, and July 2013 and are included in Appendix B of the RI Report. Creosote-treated timber piles were reported in the vicinity of shoreline structures in English Kills, near the sheen blossom reported during Low Tide Survey No. 1. The sheen blossom was observed in close proximity to the timber pile. Timber piles, particularly older timber piles, were treated with creosote and similar substances. As timber piles age and deteriorate, these substances may be released and cause sheens to appear. This area will be further evaluated during subsequent field investigations.

The locations of outfalls and CSOs that discharge to the Study Area are shown in Figure D4-6. The locations of permanently installed hard booms, used to capture floatables discharged from CSOs, are also shown in Figure D4-6. CSOs and outfalls represent current and historical potential sources for NAPL and sheen to the Study Area. CSOs also represent a source of organic material to the Study Area. Booms trap sheens and floatables, which accumulate on the upstream side of the boom. In particular, sheens were observed on the upstream (CSO) side of the Maspeth Creek boom. Sheen blossoms were not observed in Maspeth Creek during the survey, indicating the sheens were likely not associated with gas ebullition.

4.3.3 Evaluation of Lines of Evidence for NAPL Migration in Sediment and Surface Water Associated with Gas Ebullition

Once formed, gas bubbles can migrate upward through sediment when the buoyancy of the gas bubbles is sufficient to exceed the cohesive strength of the sediment. As a bubble migrates through the sediment, a bubble track forms. The upward migration of gas bubbles can provide a pathway and mechanism for NAPL transport. Residual or mobile NAPL present in the sediment can spread as NAPL or as a sheen along the gas bubble/porewater interface, attach to the bubble surface, and be transported with the bubble to surface water.

In this context "residual" and "mobile" refer to the potential for NAPL to flow through sediment under applied forces. Residual NAPL is retained in sediment pore space and will not move due to capillary forces exceeding other typical forces that would be applied to the NAPL. If the volume of NAPL in sediment pore space exceeds residual saturation, and combined forces are sufficient to mobilize the NAPL, the NAPL may move.

When the bubbles encounter the surface of the water, they break and form a sheen blossom. The sheen blossom spreads on the surface of the water and transitions to sheen, due to differences in NAPL-water interfacial tension. If the NAPL is denser than water, the NAPL may drop back through the water column to surface sediment before it spreads. Any bubble tracks that remain open in the sediment after passage of the bubble may provide higher permeability migration pathways for subsequent higher localized porewater flow.

Because a primary objective of the gas ebullition field survey was to evaluate gas ebullition as a potential transport pathway for NAPL, the survey was combined with the findings of the NAPL Evaluation (see Appendix C of the RI Report). To generally assess gas ebullition as a potential NAPL transport pathway, the following areas with NAPL observations were surveyed:

1) Category 1A observations (i.e., no NAPL) in Dutch Kills
2) A combination of Category 1A and Category 1B NAPL observations (i.e., residual NAPL) in cores located in survey areas CM 0.19 to 1.36, Maspeth Creek, and East Branch
3) A combination of Categories 1A, 1B, and 2/3 NAPL observations in survey areas CM 1.6 to 1.94, the Turning Basin, and English Kills

Research on sites where gas ebullition in sediment has been observed as a transport pathway for NAPL has generally included NAPL observations that are more consistent with NAPL observations in Category 2/3 Areas. For many sites, higher NAPL saturations in surface and shallow subsurface sediment were reported than were observed in Category 2/3 Areas. During a literature search, information could not be found that evaluated gas ebullition as a transport pathway for sediment with NAPL observations consistent with the less extensive (compared to Category 2/3 Areas) NAPL observations in Category 1B Areas.

Sheen blossoms were not observed in the Study Area during the gas ebullition field survey except for isolated sheen blossoms associated with gas bubbles (which could potentially be indicative of NAPL transport with gas ebullition) at discrete locations in the Turning Basin and English Kills (see Figure D3-8). These sheens were observed over approximately 0.02 acre (three areas in the Turning Basin, each approximately 50 square feet, and one area in English Kills, approximately 740 square feet, totaling a rounded approximation of 900 square feet), out of more than 120 acres surveyed; this represents less than 0.02% of the total surface of the Study Area. The sheen blossom observed in English Kills was observed next to wooden piles treated with creosote and may be associated with the piles rather than with NAPL in sediment.

The following lines of evidence were evaluated to assess gas ebullition as a potentially significant contaminant pathway:

- Apparent gas ebullition observations and NAPL observations in the top 5 feet of sediment are shown in Figures D4-7a through D4-7c
- Surface water sheen observations and NAPL observations in the top 5 feet of sediment are shown in Figures D4-8a through D4-8c
- Sheen blossom observations for the gas ebullition field survey and NAPL observations in the top 5 feet of sediment are shown in Figure D4-9
- Surface water total polycyclic aromatic hydrocarbon (17) (TPAH) and total petroleum hydrocarbon (TPH) concentrations are shown in Figures D4-11 through D4-16b)

NAPL observations and shake tests that confirmed NAPL in shallow subsurface sediment and surface sediment (i.e., top 5 feet) were compared to survey findings that identified areas where gas ebullition is most likely to occur. Although the depth of 5 feet is arbitrary, a combination of increased overlying pressure and reduced temperatures with depth in sediment are expected to limit the occurrence of gas ebullition (Sittoni et al. 2015).

If NAPL migration associated with gas ebullition is a significant contaminant migration pathway, evidence of NAPL migration is expected to be obvious on surface water based on the migration of NAPL to surface water from sediment. The effect of significant NAPL migration to surface water from sediment would typically be observed as sheens on surface water, or could be observed as increased concentrations of NAPL constituents, such as TPAH or TPH, in surface water samples at times favorable for gas ebullition.

4.3.3.1 Comparison of Potential NAPL Sediment Observations to Apparent Gas Ebullition and Surface Water Sheen Observations

Gas ebullition field survey observations were compared to potential NAPL observations in the top 5 feet of sediment to identify whether potential NAPL observations were generally coincident with either apparent gas ebullition areas or surface water sheen observations (see Figures D4-7a through D4-7c and Figures D4-8a through D4-8c).

Most observations of apparent gas ebullition or sheen occurred in areas with Category 1A or Category 1B cores, which either had no NAPL observations, or residual (i.e., bleb) NAPL observations, including Dutch Kills, Maspeth Creek, East Branch, and the upper reach of English Kills. These observations are described as follows:

- In **Newtown Creek, from the mouth to CM 1.0**, sheens of unknown sources were observed near outfalls during Low Tide Survey No. 2. The sheen observed from CM 0.9 to 1.0 was located adjacent to a scrap metal recycling facility bulkhead. Apparent gas ebullition was not observed. NAPL, where observed in shallow sediment, occurred only as blebs in discrete zones.
- From **Newtown Creek CM 1.0 to 2.5**, sheens of unknown sources were observed in different portions of the creek during the high tide survey and both low tide surveys. Apparent gas ebullition was observed in discrete locations and generally not associated with sheen observations. There are numerous outfalls through this portion of the Study Area, as well as a CSO. NAPL observations in the upper 5 feet of sediment are generally limited to a reach of the creek from CM 1.2 to 1.7 and occurred only as blebs in discrete zones beneath sediment without NAPL.
- In **Dutch Kills**, apparent gas ebullition and sheens were observed during each of the three surveys. The spatial extent and location of observations varied between surveys. Numerous CSOs and outfalls are present where apparent gas ebullition and sheens were observed. Sheen blossoms were not observed. Additionally, NAPL was generally not observed in Dutch Kills sediment.

- In **Maspeth Creek**, sheens of unknown source were observed during each of the three surveys, although the spatial extent of the sheens varied significantly between surveys, and widespread apparent gas ebullition was observed during the two low tide surveys. NAPL observed in shallow sediment consists of blebs in discrete zones beneath several feet of sediment with no observed NAPL. Additionally, sheen blossoms were not observed. Some combination of four pipes that are located downstream of the regulator of the Maspeth Creek CSO may discharge during dry weather and may have been a potential source for the sheens (note that sheens were not directly observed discharging from the pipes).
- From **Newtown Creek CM 2.7 through the East Branch**, a widespread sheen of unknown source was observed during the high tide survey and Low Tide Survey No. 1, and widespread apparent gas ebullition was also observed during Low Tide Survey No. 1. Apparent gas ebullition was observed in areas of limited spatial extent during the high tide survey and Low Tide Survey No. 2 adjacent to CSOs and outfalls. Residual NAPL (blebs) were observed in the shallow sediment in only 1 core (of a total of 17 cores) collected in East Branch, beneath approximately 3 feet of sediment without NAPL. Additionally, sheen blossoms were not observed in this area.
- In **upper English Kills**, sheen of an unknown source was observed during the high tide survey and Low Tide Survey No. 2, and apparent gas ebullition was observed during both the low tide surveys. However, the locations of sheen and apparent gas ebullition observations varied between surveys. It was in this area that a sheen blossom was observed immediately adjacent to creosote-treated timber piles near the head of the tributary during Low Tide Survey No. 1. NAPL was not observed in surface sediment or shallow subsurface sediment in the vicinity of the sheen blossom observation. Sheen observations during the high tide survey were observed mixed with surface scum or floatables. Sheen observations during Low Tide Survey No. 2 were observed in the vicinity of numerous outfalls, an idling vessel, and the aeration system. NAPL blebs were observed in subsurface sediment in only 1 core of 16 collected in the area, beneath several feet of sediment with no observed NAPL. Other than the observation adjacent to timber piles, sheen blossoms were not observed.

Apparent gas ebullition or sheen were observed in the vicinity of shallow sediment Category 2/3 NAPL in only two areas, the Turning Basin and lower English Kills. These observations are described as follows:

- In the **Turning Basin**, both apparent gas ebullition (see Figures D3-2c and D3-3c) and sheen (see Figures D3-5c and D3-6c) were observed during the Low Tide Survey No. 2 event in areas where Category 2/3 NAPL was observed (see Figure 4-78 in the RI Report. Sheen blossoms were observed during Low Tide Survey No. 2 at approximately CM 2.5 and 2.6. The sheen blossom at approximately CM 2.6 was observed in an area where shake tests confirmed Category 2/3 NAPL (visually coated, shake test layer) was observed in surface and shallow subsurface sediment in two cores (NC298SC-A and GPEC-GT12). In the area immediately surrounding the sheen blossom observed at CM 2.55, NAPL was not observed in the upper 5 feet of sediment but was observed 75 feet away in the surface and shallow subsurface sediment in core GPEC-SED17, where potential Category 1B NAPL (blebs) were observed. It is possible the sheen blossom originated in an area other than the immediate vicinity of the sheen blossom observation and drifted with flow to the point where the sheen blossom was observed. Based on the findings of the August 2015 gas ebullition field survey, NAPL transport via gas ebullition is limited to sheen blossoms in three discrete areas observed during one of three surveys near the time of low tide.
- In **lower English Kills**, discrete observations of sheen were observed near Category 2/3 NAPL observations in the shallow subsurface sediment during the high tide survey, and both apparent gas ebullition and sheen were observed near Category 2/3 NAPL observations during Low Tide Survey No. 2. However, sheen blossoms were not observed, suggesting the source of the surface water sheen is not the underlying sediment. Although Category 2/3 NAPL observations are present in shallow subsurface sediment, they are generally located beneath several feet of overlying sediment without NAPL. NAPL blebs were observed at the sediment surface in the vicinity of the Low Tide Survey No. 2 sheen observation at EK100SC-A. However, blebs in surface sediment were observed in only one core, so they represent (at most) an isolated potential sheen. Numerous outfalls are also located in this portion of the creek. The observation of apparent gas ebullition and sheen during the Low Tide Survey No. 2 may have also been influenced by the presence of a nearby barge being loaded with scrap metal staged on an adjacent site.

Out of 2,500 square feet of the Study Area containing Category 2/3 NAPL in the upper 5 feet of sediment, sheen blossoms were only observed over an approximately 150-square-foot area within the Turning Basin (see Figure D4-9).

The comparison of NAPL in shallow sediment and apparent gas ebullition and sheen observations does not yield a consistent relationship.

4.3.3.2 Comparison of Surface Water Chemistry to Apparent Gas Ebullition and Surface Water Sheen Observations

An additional consideration in evaluating gas ebullition as a transport pathway is the potential impact of gas ebullition on surface water chemistry. This evaluation is based on the expectation that significant migration of NAPL and NAPL constituents (e.g., TPAH and TPH) to surface water could result in observable impacts to surface water (i.e., elevated concentrations). If the NAPL was transported with gas ebullition, the highest impacts would be expected to occur during the summer when water temperatures are at seasonal highs and near the time of low tide. Impacts to surface water chemistry would, therefore, be most obvious during summer lunar low tides when temperatures are highest and hydrostatic pressures are lowest, and gas ebullition would, therefore, be expected to be most active.

TPAH and TPH concentrations for dry weather surface water samples collected from the locations shown in Figure D4-10 are included in this Gas Ebullition Evaluation. Dry weather surface water samples were collected for the RI between 2012 and 2015. Samples were collected throughout the tidal cycle and throughout the yearly seasons for TPAH and TPH.

In Figures D4-11 through D4-16b, TPAH and TPH surface water concentrations are compared to the time of year for sample collection, surface water temperature at the time of sample collection, and tidal elevation at the time of sample collection. These comparisons allow evaluation of surface water TPAH and TPH concentrations to environmental factors (water depth and temperature) that influence gas ebullition.

4.3.3.2.1 TPAH

The following comparisons between TPAH surface water concentrations and water depth and temperature are shown in the figures referenced:

- Figure D4-11 shows TPAH surface water concentrations grouped by Study Area subarea and time of year for sample collection. There is no consistent relationship between TPAH surface water concentration and time of year for sample collection. Surface water TPAH concentrations do not differ significantly by Study Area subarea, except for relatively increased concentrations in English Kills samples.
- Figure D4-12 compares TPAH surface water concentrations by Study Area subarea to surface water temperature. TPAH surface water concentrations do not significantly differ by surface water temperature or by Study Area subarea, except for relatively increased concentrations in Dutch Kills and English Kills samples with higher surface water temperatures.
- Figures D4-13a and D4-13b compare TPAH surface water concentrations to the low tide water elevations within 24 hours prior to sampling, by Study Area subarea, and by warm weather months (June through September concentrations are shown in Figure D4-13a) and colder weather months (October through May concentrations are shown in Figure D4-13b). Gas ebullition distribution and frequency would be expected to be higher at times when tides are lowest and water depths/hydrostatic pressure are lowest. If gas ebullition-facilitated NAPL transport were influencing surface water TPAH (and TPH) concentrations, concentrations would be expected to be higher after particularly low tides. Figures D4-13a and D4-13b indicate there is no consistent relationship between low tide elevation and TPAH surface water concentrations. TPAH surface water concentrations do not significantly differ when warm weather months are compared to colder weather months, except for relatively increased concentrations in Dutch Kills and English Kills samples during warmer weather months.

4.3.3.2.2 Total Petroleum Hydrocarbon

The following comparisons between TPH surface water concentrations and water depth and temperature are shown in the figures referenced:

- Figure D4-14 shows TPH surface water concentrations grouped by Study Area subarea and time of year for sample collection. There is no consistent relationship between TPH surface water concentration and time of year for sample collection. Surface water TPH concentrations do not differ significantly by Study Area subarea.
- Figure D4-15 compares TPH surface water concentrations by Study Area subarea to surface water temperature. TPH surface water concentrations do not significantly differ by surface water temperature or by Study Area subarea.
- Figures D4-16a and D4-16b compare TPH surface water concentrations to the low tide water elevations within 24 hours prior to sampling, by Study Area subarea, and by warm weather months (June through September concentrations are shown in Figure D4-16a) and colder weather months (October through May concentrations are shown in Figure D4-16b). Figures D4-16a and D4-16b indicate there is no consistent relationship between low tide elevation TPH surface water concentrations. TPH surface water concentrations do not significantly differ when warm weather months are compared to colder weather months, except for relatively increased concentrations in Dutch Kills samples during warmer weather months.

Surface water contaminants are influenced by wet weather inputs to the Study Area, compared to dry weather conditions as discussed in Sections 4.7 and 6.4 in the RI Report. Wet weather surface water contaminant concentrations are generally higher than dry weather conditions. This indicates surface water contaminant concentrations are influenced by contaminant inputs, despite the Study Area extent and associated volume of water present in the Study Area. Note that there is no apparent relationship between selected NAPL constituent surface water concentrations and the environmental factors (i.e., tidal elevation and surface water temperatures) that influence gas ebullition.

5 SUMMARY OF THE GAS EBULLITION EVALUATION

Section 5 includes a comparison of the Gas Ebullition Evaluation findings to the gas ebullition field survey program objectives. The overall objectives of the Gas Ebullition Evaluation are as follows:

- Characterize the presence and extent of apparent gas ebullition, based on the observation of gas bubbles in surface water in the Study Area, as well as the observation of sheen on surface water. Evaluate if the sheen was associated with apparent gas ebullition.
- Develop an understanding of the conditions that could affect gas ebullition in the Study Area, such as temperature, water depth, and organic material sediment content and sources (e.g., CSO discharges).

To address these objectives, a scientifically rigorous approach was developed for the gas ebullition field survey, based on the observation of gas bubbles and surface water sheens; measurement or observation of environmental conditions; and noting anthropogenic factors that could influence the observations of gas bubbles and sheen. The survey was conducted in mid-August, during peak seasonal water temperatures, when gas ebullition is expected to be most active, so it is likely a conservative record of observations of apparent gas ebullition. The surveys included two low tide surveys and one high tide survey and covered a wide range of environmental conditions in nine areas, totaling approximately 120 acres and covering approximately 70% of the Study Area.

Apparent gas ebullition was observed in all the areas surveyed throughout the survey area. The largest areas of apparent gas ebullition were observed in the Dutch Kills and East Branch tributaries and in the Turning Basin. Gas bubbles generally occurred at a moderate-high frequency and spatial distribution in the tributaries (Dutch Kills, English Kills, and East Branch) and at a trace-low frequency and spatial distribution in the main stem areas. Apparent gas ebullition was observed in more areas, at higher frequencies and with greater spatial distribution, during Low Tide Survey No. 2 than in Low Tide Survey No. 1 or High Tide Survey No. 1.

Sheens were also observed throughout all survey areas. Unlike observations of apparent gas ebullition, the distribution of sheen did not correspond to tides and varied between surveys with regard to tributary and main stem locations. Sheens that originated with gas bubbles (sheen blossoms) were observed only in the following two locations:

- Low Tide Survey No. 1, near the head of English Kills
- Low Tide Survey No. 2, in the Turning Basin

Sheen blossoms that originated with gas bubbles were not observed during High Tide Survey No. 1.

No consistent relationship was observed between apparent gas ebullition and surface water sheen observations and the distribution of NAPL in sediment. Sheen blossoms were observed over a total of 0.02 acre (900 square feet) at the head of English Kills and in the Turning Basin, out of a total of 120 acres surveyed in the Study Area, during a time of year when gas ebullition was likely near its yearly maximum. NAPL has not been observed in sediment at the head of English Kills. Here, the sheen blossoms were observed adjacent to creosote-treated timber piles, which are a potential source of sheen. Except for the discrete observation of sheen blossoms during Low Tide Survey No. 2 in the Turning Basin, sheen blossoms were not observed in areas with Category 2/3 NAPL. The Turning Basin included the Category 2/3 NAPL observations in sediment within the Study Area.

No consistent relationship was observed in the Study Area between surface water chemistry, tidal water elevations, or water temperatures favorable for gas ebullition (i.e., near the time of low tide and during seasonal high water temperature), or versus tides or seasons that are unfavorable for gas ebullition (i.e., near the time of high tide or during seasonal low water temperatures).

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TABLES

Table D2-1
Range of Environmental Conditions Surveyed

Survey Vessel	Gas Ebullition Field Survey Area	Survey Area (acres)	Environmental Conditions Assessed
1	Main stem: CM 0.19 to 0.5	10	• Water depth ranges to 20-plus feet MLLW • NAPL Category 1B Area
	Main stem: CM 0.67 to 0.83	5.1	• Frequent vessel traffic • Water depth ranges to 20-plus feet MLLW • NAPL Category 1B Area
	Main stem: CM 0.9 to 1.36	15	• Depositional/hydrodynamic conditions differ from CM 0 to 0.5 • Water depth ranges to 20-plus feet MLLW • NAPL Category 1B Area
	Main stem: CM 1.6 to 1.94	10	• Includes both NAPL Category 1B Area and CM 1.7 NAPL Category 2/3 Area
2	Dutch Kills	10	• High organic carbon input • Water depths limit access to approximately 2 to 3 hours before and after high tide • Anecdotal observations of gas bubbles[1] • NAPL Category 1A Area (NAPL not observed)
3	Turning Basin	30	• Water depth ranges from 20-plus feet to less than 5 feet MLLW • Frequent vessel traffic • Includes NAPL Category 1B Area and Turning Basin NAPL Category 2/3 Area
4	Maspeth Creek	5.6	• High organic carbon input • Water depth ranges from 20-plus feet to less than 5 feet MLLW • NAPL Category 1B Area
	East Branch	11	• High organic carbon input • NAPL Category 1B Area
5	English Kills	24	• High organic carbon input • Aeration system • Includes both NAPL Category 1B Area and Lower English Kills NAPL Category 2/3 Area

Notes:
1 = Anecdotal observations were not characterized in detail or quantified.
Total area surveyed was approximately 120 acres. Survey area shows two significant figures; due to rounding, the total value does not add up to exactly 120 acres.
High organic carbon input assumed based on the presence of CSOs.

Acronyms:
CM = creek mile
CSO = combined sewer overflow
MLLW= mean lower low water
NAPL = nonaqueous phase liquid

Table D2-2
Survey Dates and Times

Gas Ebullition Field Survey	Survey Date	Survey Start Time	Survey End Time	Time of Tide	Tidal Elevation (feet MLLW)
High Tide Survey No. 1	08/18/2015	11:30	14:55	13:02	4.24
Low Tide Survey No. 1	08/18/2015	17:15	19:30	18:36	0.67
Low Tide Survey No. 2	08/19/2015	6:00	8:15	6:53	0.52

Note:
Tidal data were obtained from National Oceanic and Atmospheric Administration for Hunter's Point, Newtown Creek, New York.

Acronym:
MLLW = mean lower low water

Table D2-3
Data Types Collected During the Gas Ebullition Field Survey

Gas Ebullition Field Survey Information	Description
Survey Area[1,2]	Survey areas as proposed in the Phase 2 FSAP Volume 2 Addendum No. 3 (CM 0.19 to 0.50, CM 0.67 to 0.83, CM 0.90 to 1.36, CM 1.60 to 1.94, Turning Basin, Dutch Kills, Maspeth Creek, East Branch, and English Kills)
Survey Event	Surveys performed during high tide (HT) and low tide (LT1) on August 18; and during low tide (LT2) on August 19; to comprise the gas ebullition field survey
Observation Time	Time of survey (hour:minute)
Observation ID	Unique location ID for an area where gas bubbles or sheen were observed (i.e., the observation area, or polygon area, as defined below)
Observation Area Miles from Newtown Creek Mouth	Creek miles are measured from the mouth (CM 0) to the head of Newtown Creek
Observation Area	Area in square feet of polygon representing gas bubble/sheen observation; areas delineated by field crews and computed in GIS
Gas Bubble Frequency	Description of the frequency of gas bubbles observed over a 5-minute period (trace-low, low-moderate, or moderate-high)
Gas Bubble Rate	Gas bubble rate (bubbles per minute)
Gas Bubble Spatial Distribution	Spatial distribution of gas bubbles within the observation area (trace-low, low-moderate, or moderate-high)
Potential Source of Gas Bubbles	Potential source of gas bubbles (aeration system operation, biota, or unknown)
Sheen Distribution	Distribution of sheen within observation area (blossom, small spots, spotty, streaks, or contiguous)
Sheen Color	Color of sheen within observation area (silvery, rainbow, dark rainbow, or dark)
Sheen Structure	Structure of sheen within observation area after disturbed (brittle or non-brittle)
Sheen Blossom Rate	Number of “blossoms” that appear during a 1-minute period
Potential Source of Sheen	Potential source of sheen (floatables, apparent gas ebullition, surface scum, vessel movement, unknown)
Water Temperature[3]	Field measurement of water temperature (°C) within 3 feet of the sediment surface in gas bubble observation area
Salinity[3]	Field measurement of salinity (psu) within 3 feet of the sediment surface in gas bubble observation area; linked to station ID
Depth Secchi Disk Disappears[3]	Field measurement of water clarity showing depth that Secchi disk disappears (feet) in gas bubble observation area; linked to station ID
Depth Secchi Disk Reappears[3]	Field measurement of water clarity showing depth that Secchi disk reappears (feet) in gas bubble observation area; linked to station ID
Approximate Water Depth at the Time of Observation	Approximate maximum water depth in apparent gas ebullition or sheen observation area in feet at time of observation, calculated using the deepest point in the observation area based on Phase 2 bathymetry combined with tide gauge height
Surface Water Quality Observation ID	Unique location ID for an area where surface water quality data were collected
Monitoring Period	Time of surface water quality measurement relative to survey (pre-survey, during survey, post-survey)
Time of Measurement	Time of surface water quality measurement (hour:minute)
Calculated Water Depth	Calculated water depth (feet) in gas bubble observation area; calculated based on position of observation and Phase 2 bathymetry combined with tide gauge height

Notes:
1 = Information was obtained from the Phase 2 FSAP Volume 2 Addendum No. 3 (Anchor QEA 2015).
2 = Creek mile is measured from the mouth (CM 0) to the head of Newtown Creek.
3 = Water quality measurement locations are linked to station ID coordinates. All other measurements/observations are linked to observation area centroid coordinates.

Acronyms:
CM = creek mile
FSAP = Field Sampling and Analysis Plan
GIS = geographic information system
psu = practical salinity unit

Reference:
Anchor QEA (Anchor QEA, LLC), 2015. *Phase 2 Field Sampling and Analysis Plan – Volume 2 Addendum No. 3* . Remedial Investigation/Feasibility Study, Newtown Creek. August 2015.

Table D3-1
Summary of Gas Bubble Observations

Survey Event	Survey Area	Observation Area ID	Observation Area Miles from Newtown Creek Mouth	Observation Date	Observation Time	Estimated Observation Area (square feet)	Approximate Water Depth at the Time of Observation (feet)	Gas Bubble Frequency	Gas Bubble Rate (bubbles per minute)	Gas Bubble Spatial Distribution	Potential Source of Gas Bubbles
HT	Dutch Kills	DK-HT-20150818-1130_1	1.448	8/18/2015	11:30	3,000	14	NA	NA	NA	Biota
HT	Dutch Kills	DK-HT-20150818-1135_1	1.438	8/18/2015	11:35	10,000	17	NA	NA	NA	Biota
HT	Dutch Kills	DK-HT-20150818-1330_1	1.439	8/18/2015	13:30	2,500	12	Trace-low	0.3	Trace-low	Unknown, therefore inferred apparent gas ebullition
HT	Dutch Kills	DK-HT-20150818-1345_1	1.434	8/18/2015	13:45	2,500	15	Low-moderate	60	Moderate-high	Unknown, therefore inferred apparent gas ebullition
HT	Maspeth Creek	MC-HT-20150818-1230_1	2.537	8/18/2015	12:30	170,000	10	NA	NA	NA	Biota
HT	East Branch	EB-HT-20150818-1519_1	3.351	8/18/2015	15:19	1,600	10	Low-moderate	30	Low-moderate	Unknown, therefore inferred apparent gas ebullition
HT	English Kills	EK-HT-20150818-1310_1	3.364	8/18/2015	13:10	300	15	NA	NA	NA	Aeration system operation
LT1	Dutch Kills	DK-LT-20150818-1734_1	1.038	8/18/2015	17:34	30	14	Trace-low	3	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT1	Dutch Kills	DK-LT-20150818-1753_1	1.173	8/18/2015	17:53	50	8	Trace-low	1	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT1	Dutch Kills	DK-LT-20150818-1814_1	1.286	8/18/2015	18:14	1,000	10	Low-moderate	50	Low-moderate	Unknown, therefore inferred apparent gas ebullition
LT1	CM 1.60-1.94	CM160194-LT-20150818-1810_1	1.558	8/18/2015	18:10	1	17	Trace-low	10	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT1	CM 1.60-1.94	CM160194-LT-20150818-1852_1	1.717	8/18/2015	18:52	1	17	Moderate-high	199	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT1	Maspeth Creek	MC-LT-20150818-1703_1	2.554	8/18/2015	17:03	230,000	7	Low-moderate	50	Moderate-high	Unknown, therefore inferred apparent gas ebullition
LT1	Maspeth Creek	MC-LT-20150818-1703_2	2.433	8/18/2015	17:03	11,000	7	Low-moderate	60	Moderate-high	Unknown, therefore inferred apparent gas ebullition
LT1	East Branch	EB-LT-20150818-1753_1	2.905	8/18/2015	17:53	200,000	19	Low-moderate	30	Low-moderate	Unknown, therefore inferred apparent gas ebullition
LT1	East Branch	EB-LT-20150818-1837_1	3.097	8/18/2015	18:37	170,000	19	Low-moderate	30	Moderate-high	Unknown, therefore inferred apparent gas ebullition
LT1	East Branch	EB-LT-20150818-1837_2	3.104	8/18/2015	18:37	18,000	10	Low-moderate	60	Moderate-high	Unknown, therefore inferred apparent gas ebullition
LT1	English Kills	EK-LT-20150818-1648_1	3.368	8/18/2015	16:48	<1	11	NA	NA	NA	Aeration system operation
LT1	English Kills	EK-LT-20150818-1825_1	3.761	8/18/2015	18:25	11,000	4	Low-moderate	50	Moderate-high	Unknown, therefore inferred apparent gas ebullition
LT1	English Kills	EK-LT-20150818-1825_2	3.767	8/18/2015	18:25	750	4	Low-moderate	50	Moderate-high	Unknown, therefore inferred apparent gas ebullition

Table D3-1
Summary of Gas Bubble Observations

Survey Event	Survey Area	Observation Area ID	Observation Area Miles from Newtown Creek Mouth	Observation Date	Observation Time	Estimated Observation Area (square feet)	Approximate Water Depth at the Time of Observation (feet)	Gas Bubble Frequency	Gas Bubble Rate (bubbles per minute)	Gas Bubble Spatial Distribution	Potential Source of Gas Bubbles
LT1	English Kills	EK-LT-20150818-1849_1	3.777	8/18/2015	18:49	22,000	6	Trace-low	5	Low-moderate	Unknown, therefore inferred apparent gas ebullition
LT2	Dutch Kills	DK-LT-20150819-0620_1	1.447	8/19/2015	6:20	31,000	15	Low-moderate	14	Moderate-high	Unknown, therefore inferred apparent gas ebullition
LT2	Dutch Kills	DK-LT-20150819-0640_1	1.249	8/19/2015	6:40	160,000	15	Moderate-high	200	Moderate-high	Unknown, therefore inferred apparent gas ebullition
LT2	Dutch Kills	DK-LT-20150819-0714_1	0.981	8/19/2015	7:14	1	8	Low-moderate	13	Low-moderate	Unknown, therefore inferred apparent gas ebullition
LT2	CM 0.90-1.36	CM090136-LT-20150819-0642_1	1.208	8/19/2015	6:42	1,500	15	Low-moderate	15	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT2	CM 0.90-1.36	CM090136-LT-20150819-0659_1	1.324	8/19/2015	6:59	310	13	Low-moderate	20	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT2	CM 0.90-1.36	CM090136-LT-20150819-0659_2	1.325	8/19/2015	6:59	310	12	Low-moderate	20	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT2	Turning Basin	TB-LT-20150819-0637_1	2.503	8/19/2015	6:37	270,000	25	Trace-low	5	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT2	Turning Basin	TB-LT-20150819-0637_2	2.52	8/19/2015	6:37	140,000	22	Low-moderate	35	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT2	Turning Basin	TB-LT-20150819-0637_3	2.66	8/19/2015	6:37	50	13	Trace-low	5	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT2	Turning Basin	TB-LT-20150819-0637_4	2.543	8/19/2015	6:37	50	15	Trace-low	5	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT2	Turning Basin	TB-LT-20150819-0637_5	2.498	8/19/2015	6:37	50	16	Trace-low	5	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT2	Turning Basin	TB-LT-20150819-0713_1	2.2	8/19/2015	7:13	75,000	21	Trace-low	7.5	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT2	Turning Basin	TB-LT-20150819-0735_1	2.424	8/19/2015	7:35	20,000	10	Low-moderate	40	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT2	Turning Basin	TB-LT-20150819-0821_1	2.529	8/19/2015	8:21	14,000	19	Trace-low	5	Trace-low	Unknown, therefore inferred apparent gas ebullition
LT2	Maspeth Creek	MC-LT-20150819-0610_1	2.428	8/19/2015	6:10	47,000	6	Low-moderate	50	Moderate-high	Unknown, therefore inferred apparent gas ebullition
LT2	Maspeth Creek	MC-LT-20150819-0658_1	2.61	8/19/2015	6:58	240,000	6	Low-moderate	50	Moderate-high	Unknown, therefore inferred apparent gas ebullition
LT2	East Branch	EB-LT-20150819-0740_1	2.982	8/19/2015	7:40	16,000	8	NA	NA	NA	Biota
LT2	East Branch	EB-LT-20150819-0802_1	3.044	8/19/2015	8:02	1	8	NA	NA	NA	Biota
LT2	East Branch	EB-LT-20150819-0811_1	3.165	8/19/2015	8:11	19,000	12	Low-moderate	30	Trace-low	Unknown, therefore inferred apparent gas ebullition

Table D3-1
Summary of Gas Bubble Observations

Survey Event	Survey Area	Observation Area ID	Observation Area Miles from Newtown Creek Mouth	Observation Date	Observation Time	Estimated Observation Area (square feet)	Approximate Water Depth at the Time of Observation (feet)	Gas Bubble Frequency	Gas Bubble Rate (bubbles per minute)	Gas Bubble Spatial Distribution	Potential Source of Gas Bubbles
LT2	English Kills	EK-LT-20150819-0644_1	3.465	8/19/2015	6:44	10	8	NA	NA	NA	Aeration system operation
LT2	English Kills	EK-LT-20150819-0701_1	3.332	8/19/2015	7:01	24,000	19	Moderate-high	150	Moderate-high	Unknown, therefore inferred apparent gas ebullition
LT2	English Kills	EK-LT-20150819-0710_1	3.323	8/19/2015	7:10	46,000	22	Low-moderate	100	Moderate-high	Unknown, therefore inferred apparent gas ebullition
LT2	English Kills	EK-LT-20150819-0734_1	3.013	8/19/2015	7:34	180,000	22	Moderate-high	150	Moderate-high	Unknown, therefore inferred apparent gas ebullition
LT2	English Kills	EK-LT-20150819-0822_1	3.491	8/19/2015	8:22	1	5	Moderate-high	125	Low-moderate	Unknown, therefore inferred apparent gas ebullition

Notes:
Gas bubble frequency describes how often gas bubbles were observed over a 5-minute period.
Trace-low = Bubbles appear, but less frequently than low-moderate with regard to time within the observation area.
Low-moderate = Bubbles appear intermittently or irregularly, with regard to time within the observation area.
Moderate-high = Bubbles are observed continuously, or nearly continuously, with regard to time within the observation area.
Gas bubble rate describes the number of bubbles observed per minute.
Gas bubble spatial distribution describes the distribution of bubbles within the observation area.
Trace-low = Bubbles occur only at specific, localized points within the observation area.
Low-moderate = Bubbles appear intermittently or irregularly within the observation area.
Moderate-high = Bubbles are widespread within the observation area.
Potential source of gas bubbles describes whether the appearance of gas bubbles is potentially caused by the presence of an aeration system, biota, or is unknown. If the potential source of gas bubbles is unknown, it is inferred apparent gas ebullition.
Estimated observation area shows two significant figures.

Acronyms:
CM = creek mile
HT = High Tide Survey No. 1, conducted on August 18, 2015
LT1 = Low Tide Survey No. 1, conducted on August 18, 2015
LT2 = Low Tide Survey No. 2, conducted on August 19, 2015
NA = not applicable/not available

Table D3-2
Summary of Sheen Observations

Survey Event	Survey Area	Observation Area ID	Observation Area Miles from Newtown Creek Mouth	Observation Date	Observation Time	Estimated Observation Area (square feet)	Approximate Water Depth at the Time of Observation (feet)	Sheen Distribution	Sheen Color	Sheen Structure	Sheen Blossom Rate (blossoms per minute)	Potential Source of Sheen
HT	Dutch Kills	DK-HT-20150818-1130_1	1.448	8/18/2015	11:30	3,000	14	Small spots	Silvery	Brittle	-	Unknown
HT	Dutch Kills	DK-HT-20150818-1135_1	1.438	8/18/2015	11:35	10,000	17	Small spots	Silvery	Brittle	-	Unknown
HT	Dutch Kills	DK-HT-20150818-1200_1	1.312	8/18/2015	12:00	100,000	19	Small spots	Silvery	Brittle	-	Unknown
HT	Dutch Kills	DK-HT-20150818-1230_1	1.129	8/18/2015	12:30	99,000	18	Small spots	Silvery	Brittle	-	Unknown
HT	Dutch Kills	DK-HT-20150818-1330_1	1.439	8/18/2015	13:30	2,500	12	Small spots	Silvery	Non-brittle	-	Floatables
HT	Dutch Kills	DK-HT-20150818-1345_1	1.434	8/18/2015	13:45	2,500	15	Small spots	Silvery	Non-brittle	-	Surface scum
HT	CM 1.60-1.94	CM160194-HT-20150818-1214_1	1.597	8/18/2015	12:14	38,000	28	Contiguous	Silvery	Non-brittle	-	Floatables
HT	Turning Basin	TB-HT-20150818-1231_1	2.525	8/18/2015	12:31	130	20	Spotty	Rainbow	Brittle	-	Unknown
HT	Turning Basin	TB-HT-20150818-1301_1	2.314	8/18/2015	13:01	50	17	Spotty	Rainbow	Brittle	-	Unknown
HT	Turning Basin	TB-HT-20150818-1411_1	2.473	8/18/2015	14:11	10	22	Spotty	Rainbow	Brittle	-	Unknown
HT	Turning Basin	TB-HT-20150818-1421_1	2.324	8/18/2015	14:21	530	23	Spotty	Rainbow	Brittle	-	Unknown
HT	Maspeth Creek	MC-HT-20150818-1300_1	2.471	8/18/2015	13:00	10	5	Small spots	Silvery	Brittle	-	Surface scum
HT	East Branch	EB-HT-20150818-1455_1	2.990	8/18/2015	14:55	250	12	Small spots	Silvery	Non-brittle	-	Unknown
HT	East Branch	EB-HT-20150818-1455_2	2.990	8/18/2015	14:55	400,000	21	Small spots	Silvery	Non-brittle	-	Unknown
HT	East Branch	EB-HT-20150818-1519_1	3.351	8/18/2015	15:19	1,600	10	Small spots	Silvery	Non-brittle	-	Unknown
HT	English Kills	EK-HT-20150818-1155_1	3.404	8/18/2015	11:55	1	19	Spotty	Silvery	Non-brittle	-	Surface scum
HT	English Kills	EK-HT-20150818-1232_1	3.629	8/18/2015	12:32	50	10	Small spots	Silvery	Non-brittle	-	Floatables
HT	English Kills	EK-HT-20150818-1322_1	3.313	8/18/2015	13:22	160	5	Spotty	Rainbow	Non-brittle	-	Surface scum
HT	English Kills	EK-HT-20150818-1352_1	3.106	8/18/2015	13:52	150	12	Spotty	Silvery	Non-brittle	-	Surface scum
HT	English Kills	EK-HT-20150818-1404_1	3.052	8/18/2015	14:04	710	18	Small spots	Rainbow	Brittle	-	Unknown
HT	English Kills	EK-HT-20150818-1418_1	2.975	8/18/2015	14:18	180	16	Streaks	Silvery	Non-brittle	-	Unknown
LT1	Dutch Kills	DK-LT-20150818-1734_2	1.038	8/18/2015	17:34	530	14	Small spots	Silvery	Non-brittle	-	Surface scum
LT1	Dutch Kills	DK-LT-20150818-1753_2	1.173	8/18/2015	17:53	150	8	Small spots	Rainbow	Non-brittle	-	Unknown
LT1	Dutch Kills	DK-LT-20150818-1806_1	1.250	8/18/2015	18:06	1,100	4	Small spots	Silvery	Brittle	-	Unknown
LT1	Dutch Kills	DK-LT-20150818-1814_1	1.286	8/18/2015	18:14	1,000	10	Small spots	Silvery	Brittle	-	Surface scum
LT1	CM 1.60-1.94	CM160194-LT-20150818-1825_1	1.917	8/18/2015	18:25	570	14	Streaks	Rainbow	Non-brittle	-	Unknown
LT1	East Branch	EB-LT-20150818-1753_1	2.905	8/18/2015	17:53	200,000	19	Streaks	Silvery	Non-brittle	-	Unknown
LT1	East Branch	EB-LT-20150818-1837_1	3.097	8/18/2015	18:37	170,000	19	Streaks	Silvery	Non-brittle	-	Unknown
LT1	East Branch	EB-LT-20150818-1837_2	3.104	8/18/2015	18:37	18,000	10	Streaks	Silvery	Non-brittle	-	Unknown
LT1	English Kills	EK-LT-20150818-1825_2	3.767	8/18/2015	18:25	750	4	Blossom	Silvery	Non-brittle	1	Apparent gas ebullition
LT2	CM 0.19-0.50	CM019050-LT-20150819-0833_1	0.349	8/19/2015	8:33	200	6	Small spots	Silvery	Brittle	-	Unknown
LT2	CM 0.67-0.83	CM067083-LT-20150819-0910_1	0.705	8/19/2015	9:10	400	14	Spotty	Rainbow	Non-brittle	-	Surface scum
LT2	Dutch Kills	DK-LT-20150819-0701_1	1.068	8/19/2015	7:01	64,000	14	Spotty	Silvery	Brittle	-	Unknown
LT2	CM 0.90-1.36	CM090136-LT-20150819-0601_1	0.999	8/19/2015	6:01	8,900	22	Small spots	Silvery	Brittle	-	Floatables
LT2	CM 0.90-1.36	CM090136-LT-20150819-0619_1	1.162	8/19/2015	6:19	20	17	Small spots	Silvery	Brittle	-	Unknown
LT2	CM 0.90-1.36	CM090136-LT-20150819-0642_2	1.206	8/19/2015	6:42	750	17	Small spots	Silvery	Brittle	-	Unknown

Table D3-2
Summary of Sheen Observations

Survey Event	Survey Area	Observation Area ID	Observation Area Miles from Newtown Creek Mouth	Observation Date	Observation Time	Estimated Observation Area (square feet)	Approximate Water Depth at the Time of Observation (feet)	Sheen Distribution	Sheen Color	Sheen Structure	Sheen Blossom Rate (blossoms per minute)	Potential Source of Sheen
LT2	CM 0.90-1.36	CM090136-LT-20150819-0715_1	1.041	8/19/2015	7:15	1,000	21	Streaks	Silvery	Brittle	-	Unknown
LT2	CM 1.60-1.94	CM160194-LT-20150819-0752_1	1.877	8/19/2015	7:52	17,000	17	Spotty	Silvery	Brittle	-	Unknown
LT2	CM 1.60-1.94	CM160194-LT-20150819-0752_2	1.946	8/19/2015	7:52	17,000	17	Spotty	Silvery	Brittle	-	Unknown
LT2	Turning Basin	TB-LT-20150819-0637_1	2.503	8/19/2015	6:37	270,000	25	Spotty, streaks	Silvery, dark	Brittle	-	Unknown
LT2	Turning Basin	TB-LT-20150819-0637_2	2.520	8/19/2015	6:37	140,000	22	Spotty, streaks	Silvery, dark	Brittle	-	Unknown
LT2	Turning Basin	TB-LT-20150819-0637_3	2.660	8/19/2015	6:37	50	13	Blossom	Dark	Non-brittle	0.2	Apparent gas ebullition
LT2	Turning Basin	TB-LT-20150819-0637_4	2.543	8/19/2015	6:37	50	15	Blossom	Dark	Non-brittle	0.2	Apparent gas ebullition
LT2	Turning Basin	TB-LT-20150819-0637_5	2.498	8/19/2015	6:37	50	16	Blossom	Dark	Non-brittle	0.2	Apparent gas ebullition
LT2	Turning Basin	TB-LT-20150819-0713_1	2.200	8/19/2015	7:13	75,000	21	Streaks	Silvery	Non-brittle	-	Unknown
LT2	Turning Basin	TB-LT-20150819-0821_1	2.529	8/19/2015	8:21	14,000	19	Streaks	Rainbow, dark	Non-brittle	-	Unknown
LT2	Maspeth Creek	MC-LT-20150819-0610_1	2.428	8/19/2015	6:10	47,000	6	Contiguous	Silvery	Non-brittle	-	Floatables
LT2	East Branch	EB-LT-20150819-0811_1	3.165	8/19/2015	8:11	19,000	12	Streaks	Rainbow	Non-brittle	-	Surface scum
LT2	English Kills	EK-LT-20150819-0701_1	3.332	8/19/2015	7:01	24,000	19	Spotty	Rainbow	Non-brittle	-	Vessel movement
LT2	English Kills	EK-LT-20150819-0710_1	3.323	8/19/2015	7:10	46,000	22	Small spots	Rainbow	Non-brittle	-	Vessel movement
LT2	English Kills	EK-LT-20150819-0726_1	3.081	8/19/2015	7:26	7,900	20	Spotty	Rainbow	Brittle	-	Vessel movement
LT2	English Kills	EK-LT-20150819-0742_1	2.964	8/19/2015	7:42	15,000	20	Spotty	Rainbow	Brittle	-	Vessel movement
LT2	English Kills	EK-LT-20150819-0809_1	3.310	8/19/2015	8:09	2,000	3	Contiguous	Rainbow	Non-brittle	-	Unknown

Notes:
- = Sheen blossoms not observed
Sheen distribution describes the sheen present on the surface within the observation area.
Blossom = observations of a sheen area (less than 3 feet in diameter) developing when a gas bubble breaks on the water surface
Small spots = isolated patches (less than 3 feet in diameter) of sheen
Spotty = larger areas of sheen that comprise many smaller patches (less than 3 feet in diameter) of sheen that may merge or separate over time
Streaks = flat lines of sheen
Contiguous = larger patch of sheen (greater than 3 feet in diameter)
Sheen color describes whether the sheen is transparent, metallic, or multicolored.
Silvery = metallic, near transparent to silver/gray
Rainbow = multicolored
Dark = dark metallic (reflects/mirrors the color of the sky) or brown/black colored
Sheen structure describes how the sheen appears when disturbed.
Brittle = sheen cracks and breaks apart when disturbed
Non-brittle = sheen coalesces after being disturbed
Sheen blossom rate refers to the number of “blossoms” that appear during a 1-minute period.
Potential source of sheen describes whether the appearance of sheen is due to the presence of floatables, apparent gas ebullition, surface scum, or vessel movement, or is unknown.
Estimated observation area shows two significant figures.

Acronyms:
CM = creek mile
HT = High Tide Survey No. 1, conducted on August 18, 2015
LT1 = Low Tide Survey No. 1, conducted on August 18, 2015
LT2 = Low Tide Survey No. 2, conducted on August 19, 2015
NA = not applicable/not available

Table D3-3a
Summary of Surface Water Quality Measurements for High Tide Survey No. 1 – Conducted on August 18, 2015

Surface Water Quality Observation ID	Survey Area	Monitoring Period	Observation ID Miles from Newtown Creek Mouth	Time of Measurement	Water Temperature (°C)	Salinity (psu)	Depth Secchi Disk Disappears (feet)	Depth Secchi Disk Reappears (feet)	Calculated Water Depth (feet)
NC322SW	CM 0.19 – 0.50	Pre-survey	0.276	11:26	24.3	24.5	2.1	NA	22
NC323SW	CM 0.19 – 0.50	Pre-survey	0.481	11:17	24.4	24.3	2.3	NA	23
NC322SW	CM 0.19 – 0.50	Post-survey	0.230	15:46	24.5	24.3	2.5	NA	21
NC323SW	CM 0.19 – 0.50	Post-survey	0.489	15:40	24.7	24.1	2.1	NA	20
NC324SW	CM 0.67 – 0.83	Pre-survey	0.777	10:56	24.3	24.3	2.3	NA	20
NC324SW	CM 0.67 – 0.83	Post-survey	0.751	15:33	24.8	24.9	NA	NA	21
DK056SW	Dutch Kills	Pre-survey	1.187	11:05	25.0	23.2	1.7	1.3	13
DK057SW	Dutch Kills	Pre-survey	1.446	11:15	24.9	23.3	1.3	1.0	12
DK-HT-20150818-1130_1	Dutch Kills	During Survey	1.448	11:30	24.9	23.2	1.3	1.0	14
DK-HT-20150818-1135_1	Dutch Kills	During Survey	1.438	11:35	24.1	23.7	1.3	1.0	17
DK-HT-20150818-1200_1	Dutch Kills	During Survey	1.312	12:00	24.8	23.6	2.0	1.3	19
DK-HT-20150818-1230_1	Dutch Kills	During Survey	1.129	12:30	23.9	24.6	2.0	1.2	18
DK-HT-20150818-1330_1	Dutch Kills	During Survey	1.439	13:30	24.4	23.7	1.4	1.1	12
DK-HT-20150818-1345_1	Dutch Kills	During Survey	1.434	13:45	24.4	23.7	1.4	1.1	15
DK056SW	Dutch Kills	Post-survey	1.190	14:38	24.6	23.8	1.7	1.5	12
DK057SW	Dutch Kills	Post-survey	1.448	14:30	24.7	23.6	2.3	2.0	10
NC325SW	CM 0.90 – 1.36	Pre-survey	1.041	10:59	24.7	23.9	2.3	1.8	29
NC326SW	CM 0.90 – 1.36	Pre-survey	1.197	11:12	24.8	23.8	2.4	2.0	25
NC325SW	CM 0.90 – 1.36	Post-survey	1.033	15:26	24.2	24.3	2.3	NA	28
NC326SW	CM 0.90 – 1.36	Post-survey	1.206	15:20	24.5	24.3	2.3	NA	24
NC327SW	CM 1.60 – 1.94	Pre-survey	1.668	11:24	24.9	23.7	1.9	1.5	23
NC328SW	CM 1.60 – 1.94	Pre-survey	1.881	11:31	24.9	23.2	2.5	2.1	26
NC327SW	CM 1.60 – 1.94	Post-survey	1.670	15:10	24.5	24.4	2.3	NA	21
NC328SW	CM 1.60 – 1.94	Post-survey	1.874	15:04	24.5	24.4	2.4	NA	24
NC329SW	Turning Basin	Pre-survey	2.323	11:59	24.8	22.8	1.4	1.0	23
NC330SW	Turning Basin	Pre-survey	2.485	12:07	24.7	23.3	3.2	2.7	11
NC331SW	Turning Basin	Pre-survey	2.625	12:16	24.7	23.3	2.0	1.8	18
NC329SW	Turning Basin	Post-survey	2.322	14:44	25.6	22.7	2.3	2.0	17
NC330SW	Turning Basin	Post-survey	2.467	14:55	24.8	23.3	2.8	2.6	15
NC331SW	Turning Basin	Post-survey	2.622	15:05	24.7	23.5	4.0	3.8	18
MC032SW	Maspeth Creek	Pre-survey	2.492	12:02	24.9	22.8	1.8	1.5	5
MC-HT-20150818-1230_1	Maspeth Creek	During Survey	2.537	12:30	24.9	22.5	1.4	1.2	10
MC032SW	Maspeth Creek	Post-survey	2.502	14:10	25.0	22.7	1.6	1.4	5
EB054SW	East Branch	Pre-survey	2.834	11:17	24.2	23.9	2.8	2.3	21
EB055SW	East Branch	Pre-survey	2.982	14:43	24.6	22.6	2.4	2.0	8
EB056SW	East Branch	Pre-survey	3.095	15:07	24.1	23.3	1.5	1.1	7
EB-HT-20150818-1519_1	East Branch	During Survey	3.351	15:19	24.0	23.0	1.2	1.0	10
EB054SW	East Branch	Post-survey	2.821	15:50	25.1	23.4	2.9	2.6	24

Table D3-3a
Summary of Surface Water Quality Measurements for High Tide Survey No. 1 – Conducted on August 18, 2015

Surface Water Quality Observation ID	Survey Area	Monitoring Period	Observation ID Miles from Newtown Creek Mouth	Time of Measurement	Water Temperature (°C)	Salinity (psu)	Depth Secchi Disk Disappears (feet)	Depth Secchi Disk Reappears (feet)	Calculated Water Depth (feet)
EB055SW	East Branch	Post-survey	2.982	15:54	25.1	22.5	2.6	2.1	7
EB056SW	East Branch	Post-survey	3.087	16:01	24.7	22.8	1.9	1.6	9
EK109SW	English Kills	Pre-survey	2.930	11:24	24.4	23.6	3.8	3.3	20
EK110SW	English Kills	Pre-survey	3.229	11:38	25.5	23.3	4.5	4.3	10
EK111SW	English Kills	Pre-survey	3.563	12:15	24.9	22.7	3.1	2.8	10
EK-HT-20150818-1310_1	English Kills	During Survey	3.364	13:10	24.6	23.1	2.9	2.6	15
EK109SW	English Kills	Post-survey	2.933	15:14	25.0	23.4	4.7	4.5	21
EK110SW	English Kills	Post-survey	3.221	15:23	25.0	23.2	5.4	5.0	21
EK111SW	English Kills	Post-survey	3.539	15:36	25.4	22.5	3.5	3.3	13

Notes:
Calculated water depth is the water depth (feet) at the time of collection and is calculated from tide gauge height and Phase 2 bathymetry.
The creek mile associated with a surface water quality measurement collected in conjunction with a gas ebullition or sheen observation reflects the centerpoint of the gas ebullition or sheen observation area.

Acronyms:
CM = creek mile
NA = not available (measurement not recorded)
psu = practical salinity unit

Table D3-3b
Summary of Surface Water Quality Measurements for Low Tide Survey No. 1 – Conducted on August 18, 2015

Surface Water Quality Observation ID	Survey Area	Monitoring Period	Observation ID Miles from Newtown Creek Mouth	Time of Measurement	Water Temperature (°C)	Salinity (psu)	Depth Secchi Disk Disappears (feet)	Depth Secchi Disk Reappears (feet)	Calculated Water Depth (feet)
NC322SW	CM 0.19 – 0.50	Pre-survey	0.140	19:41	25.0	24.3	3.3	3.1	7
NC323SW	CM 0.19 – 0.50	Pre-survey	0.294	19:47	25.0	24.0	2.9	2.5	7
NC322SW	CM 0.19 – 0.50	Post-survey	0.233	20:25	24.7	24.6	2.7	NA	20
NC323SW	CM 0.19 – 0.50	Post-survey	0.478	20:21	24.8	24.5	2.1	NA	17
NC324SW	CM 0.67 – 0.83	Pre-survey	0.688	19:18	25.6	23.3	2.9	2.5	16
NC324SW	CM 0.67 – 0.83	Post-survey	0.750	20:16	25.0	24.1	2.4	NA	22
DK056SW	Dutch Kills	Pre-survey	1.191	17:25	24.7	23.7	1.2	0.9	12
DK057SW	Dutch Kills	Pre-survey	1.447	18:32	26.0	20.7	1.0	0.7	10
DK-LT-20150818-1734_1	Dutch Kills	During Survey	1.038	17:34	25.3	23.0	1.4	1.1	14
DK-LT-20150818-1734_2	Dutch Kills	During Survey	1.038	17:34	25.3	23.0	1.4	1.1	14
DK-LT-20150818-1753_1	Dutch Kills	During Survey	1.173	17:53	25.7	21.8	1.2	1.0	8
DK-LT-20150818-1753_2	Dutch Kills	During Survey	1.173	17:53	25.7	21.8	1.2	1.0	8
DK-LT-20150818-1814_1	Dutch Kills	During Survey	1.286	18:14	26.6	19.9	1.0	0.7	10
DK056SW	Dutch Kills	Post-survey	1.185	19:17	24.6	23.9	1.2	1.0	11
DK057SW	Dutch Kills	Post-survey	1.448	19:07	24.7	23.7	1.0	0.8	9
NC325SW	CM 0.90 – 1.36	Pre-survey	1.042	17:51	26.0	22.6	2.8	2.3	21
NC326SW	CM 0.90 – 1.36	Pre-survey	1.240	17:28	26.3	22.6	3.7	3.1	23
NC325SW	CM 0.90 – 1.36	Post-survey	1.042	20:21	25.6	23.1	2.4	2.0	23
NC326SW	CM 0.90 – 1.36	Post-survey	1.240	20:16	25.5	23.3	2.0	1.7	24
NC327SW	CM 1.60 – 1.94	Pre-survey	1.555	19:03	25.8	22.8	2.6	2.3	25
NC328SW	CM 1.60 – 1.94	Pre-survey	1.925	18:35	25.4	23.2	3.0	2.2	10
CM160194-LT-20150818-1810_1	CM 1.60 – 1.94	During Survey	1.558	18:10	25.5	23.4	2.7	2.5	17
CM160194-LT-20150818-1852_1	CM 1.60 – 1.94	During Survey	1.717	18:52	25.4	23.2	2.8	2.4	17
NC327SW	CM 1.60 – 1.94	Post-survey	1.555	20:10	25.6	23.1	2.0	1.8	26
NC328SW	CM 1.60 – 1.94	Post-survey	1.870	20:05	24.6	24.9	2.7	NA	22
NC329SW	Turning Basin	Pre-survey	2.320	16:57	24.5	23.8	2.7	NA	20
NC330SW	Turning Basin	Pre-survey	2.467	17:05	25.5	22.9	2.0	NA	8
NC331SW	Turning Basin	Pre-survey	2.638	17:11	24.3	23.8	2.4	NA	18
NC329SW	Turning Basin	Post-survey	2.387	19:05	24.6	24.1	2.3	NA	24
NC330SW	Turning Basin	Post-survey	2.520	19:17	24.5	24.6	2.4	NA	9
NC331SW	Turning Basin	Post-survey	2.632	19:24	24.5	23.9	2.3	NA	17
MC032SW	Maspeth Creek	Pre-survey	2.504	16:58	27.1	20.7	1.5	1.2	2
MC-LT-20150818-1703_1	Maspeth Creek	During Survey	2.554	17:03	27.6	18.3	NA	NA	7
MC-LT-20150818-1703_2	Maspeth Creek	During Survey	2.433	17:03	27.6	18.3	NA	NA	7
MC032SW	Maspeth Creek	Post-survey	2.508	19:59	25.3	22.3	1.7	1.4	3
EB054SW	East Branch	Pre-survey	2.847	17:42	24.5	22.7	3.0	2.5	14
EB055SW	East Branch	Pre-survey	2.982	18:22	24.1	23.1	2.3	2.0	6
EB056SW	East Branch	Pre-survey	3.096	18:33	24.4	23.0	1.7	1.4	8

Table D3-3b
Summary of Surface Water Quality Measurements for Low Tide Survey No. 1 – Conducted on August 18, 2015

Surface Water Quality Observation ID	Survey Area	Monitoring Period	Observation ID Miles from Newtown Creek Mouth	Time of Measurement	Water Temperature (°C)	Salinity (psu)	Depth Secchi Disk Disappears (feet)	Depth Secchi Disk Reappears (feet)	Calculated Water Depth (feet)
EB-LT-20150818-1753_1	East Branch	During Survey	2.905	17:53	24.6	23.2	2.0	1.6	19
EB-LT-20150818-1837_1	East Branch	During Survey	3.097	18:37	24.4	23.0	1.7	1.4	19
EB-LT-20150818-1837_2	East Branch	During Survey	3.104	18:37	24.4	23.0	1.7	1.4	10
EB054SW	East Branch	Post-survey	2.844	19:14	24.0	23.9	3.8	3.5	13
EB055SW	East Branch	Post-survey	2.982	19:22	25.1	22.8	2.4	2.0	7
EB056SW	East Branch	Post-survey	3.096	19:28	24.5	22.9	1.3	1.1	9
EK109SW	English Kills	Pre-survey	2.934	19:32	24.9	23.3	5.0	4.5	15
EK110SW	English Kills	Pre-survey	3.225	19:13	25.1	22.8	4.2	3.8	9
EK111SW	English Kills	Pre-survey	3.577	17:06	25.8	21.8	2.2	1.9	10
EK-LT-20150818-1648_1	English Kills	During Survey	3.368	16:48	25.4	23.6	3.3	2.7	11
EK-LT-20150818-1825_1	English Kills	During Survey	3.761	18:25	25.2	20.8	1.9	1.8	4
EK-LT-20150818-1825_2	English Kills	During Survey	3.767	18:25	25.2	20.8	1.9	1.8	4
EK-LT-20150818-1849_1	English Kills	During Survey	3.777	18:49	20.1	21.6	1.1	1.9	6
EK110SW	English Kills	Post-survey	3.223	19:51	25.2	23.0	3.3	NA	17
EK111SW	English Kills	Post-survey	3.587	19:45	25.7	22.0	3.3	NA	12

Notes:
Calculated water depth is the water depth (feet) at the time of collection and is calculated from tide gauge height and Phase 2 bathymetry.
The creek mile associated with a surface water quality measurement collected in conjunction with a gas ebullition or sheen observation reflects the centerpoint of the gas ebullition or sheen observation area.

Acronyms:
CM = creek mile
NA = not available (measurement not recorded)
psu = practical salinity unit

Table D3-3c
Summary of Surface Water Quality Measurements for Low Tide Survey No. 2 – Conducted on August 19, 2015

Surface Water Quality Observation ID	Survey Area	Monitoring Period	Observation ID Miles from Newtown Creek Mouth	Time of Measurement	Water Temperature (°C)	Salinity (psu)	Depth Secchi Disk Disappears (feet)	Depth Secchi Disk Reappears (feet)	Calculated Water Depth (feet)
NC323SW	CM 0.19 – 0.50	Pre-survey	0.475	8:28	24.9	24.0	2.8	2.3	16
NC322SW	CM 0.19 – 0.50	Post-survey	0.224	9:26	24.6	24.4	4.8	4.4	21
NC323SW	CM 0.19 – 0.50	Post-survey	0.470	9:34	24.7	24.3	3.1	2.6	16
NC324SW	CM 0.67 – 0.83	Pre-survey	0.804	8:49	38.4	24.4	1.9	1.6	19
NC324SW	CM 0.67 – 0.83	Post-survey	0.789	9:17	24.7	24.4	2.8	2.4	17
DK056SW	Dutch Kills	Pre-survey	1.184	6:01	25.5	22.4	1.8	1.4	11
DK057SW	Dutch Kills	Pre-survey	1.447	6:15	25.6	21.9	1.7	1.3	9
DK-LT-20150819-0620_1	Dutch Kills	During Survey	1.447	6:20	25.6	21.6	1.4	1.2	15
DK-LT-20150819-0640_1	Dutch Kills	During Survey	1.249	6:40	25.7	22.2	1.8	1.5	15
DK-LT-20150819-0714_1	Dutch Kills	During Survey	0.981	7:14	25.2	23.1	2.1	1.8	8
DK056SW	Dutch Kills	Post-survey	1.188	7:42	25.3	22.1	2.2	1.6	11
DK057SW	Dutch Kills	Post-survey	1.444	7:56	25.4	22.6	1.7	1.5	9
NC325SW	CM 0.90 – 1.36	Pre-survey	1.050	7:22	24.8	24.4	2.8	2.3	17
NC326SW	CM 0.90 – 1.36	Pre-survey	1.192	6:28	25.0	23.6	3.5	3.1	18
CM090136-LT-20150819-0642_1	CM 0.90 – 1.36	During Survey	1.208	6:42	24.8	23.9	3.0	2.7	15
CM090136-LT-20150819-0642_2	CM 0.90 – 1.36	During Survey	1.206	6:42	24.8	23.9	3.0	2.7	17
CM090136-LT-20150819-0659_1	CM 0.90 – 1.36	During Survey	1.324	6:59	25.0	23.5	3.3	3.0	12
CM090136-LT-20150819-0659_2	CM 0.90 – 1.36	During Survey	1.325	6:59	25.0	23.5	3.3	3.0	12
NC325SW	CM 0.90 – 1.36	Post-survey	1.027	8:41	25.0	22.9	2.0	1.8	27
NC326SW	CM 0.90 – 1.36	Post-survey	1.186	8:35	25.0	22.9	2.0	1.6	22
NC327SW	CM 1.60 – 1.94	Pre-survey	1.652	7:58	24.7	24.0	2.7	2.3	15
NC328SW	CM 1.60 – 1.95	Pre-survey	1.871	7:41	24.7	24.0	3.1	2.8	20
NC327SW	CM 1.60 – 1.96	Post-survey	1.676	8:19	24.9	23.0	2.6	2.3	17
NC328SW	CM 1.60 – 1.97	Post-survey	1.868	8:25	24.8	23.0	3.0	2.5	23
NC329SW	Turning Basin	Pre-survey	2.322	6:17	24.1	24.1	2.6	2.5	19
NC330SW	Turning Basin	Pre-survey	2.480	6:24	24.9	23.4	3.1	2.9	9
NC331SW	Turning Basin	Pre-survey	2.640	6:31	24.4	23.8	5.0	4.1	16
TB-LT-20150819-0637_1	Turning Basin	During Survey	2.503	6:37	24.5	23.7	4.5	3.9	25
TB-LT-20150819-0637_2	Turning Basin	During Survey	2.520	6:37	24.5	23.7	4.5	3.9	22
TB-LT-20150819-0637_3	Turning Basin	During Survey	2.660	6:37	24.5	23.7	4.5	3.9	13
TB-LT-20150819-0637_4	Turning Basin	During Survey	2.543	6:37	24.5	23.7	4.5	3.9	15
TB-LT-20150819-0637_5	Turning Basin	During Survey	2.498	6:37	24.5	23.7	4.5	3.9	16
TB-LT-20150819-0713_1	Turning Basin	During Survey	2.200	7:13	24.6	23.7	3.2	2.8	21
TB-LT-20150819-0735_1	Turning Basin	During Survey	2.424	7:35	24.8	23.4	3.0	2.7	10
TB-LT-20150819-0821_1	Turning Basin	During Survey	2.529	8:21	25.0	23.2	3.6	3.2	19
NC329SW	Turning Basin	Post-survey	2.324	8:43	24.6	24.0	2.8	2.2	21
NC330SW	Turning Basin	Post-survey	2.481	8:52	24.7	23.5	3.3	3.0	13
NC331SW	Turning Basin	Post-survey	2.640	8:58	24.4	23.9	3.7	3.4	16

Table D3-3c
Summary of Surface Water Quality Measurements for Low Tide Survey No. 2 – Conducted on August 19, 2015

Surface Water Quality Observation ID	Survey Area	Monitoring Period	Observation ID Miles from Newtown Creek Mouth	Time of Measurement	Water Temperature (°C)	Salinity (psu)	Depth Secchi Disk Disappears (feet)	Depth Secchi Disk Reappears (feet)	Calculated Water Depth (feet)
MC032SW	Maspeth Creek	Pre-survey	2.498	7:17	23.1	13.0	1.2	NA	1
MC-LT-20150819-0610_1	Maspeth Creek	During Survey	2.428	6:10	24.8	22.6	1.2	NA	6
MC-LT-20150819-0658_1	Maspeth Creek	During Survey	2.610	6:58	23.2	16.5	NA	NA	6
MC032SW	Maspeth Creek	Post-survey	2.508	9:09	24.8	23.3	2.1	NA	3
EB054SW	East Branch	Pre-survey	2.836	7:54	24.6	23.0	8.3	NA	13
EB055SW	East Branch	Pre-survey	2.982	8:04	24.5	23.5	1.2	NA	3
EB056SW	East Branch	Pre-survey	2.836	8:33	24.6	23.5	2.3	NA	13
EB-LT-20150819-0740_1	East Branch	During Survey	2.982	7:40	24.5	23.2	NA	NA	8
EB-LT-20150819-0811_1	East Branch	During Survey	3.165	8:11	24.4	23.4	1.7	NA	12
EB054SW	East Branch	Post-survey	2.836	8:41	24.4	23.5	2.5	NA	11
EB055SW	East Branch	Post-survey	2.982	8:48	24.5	23.6	1.3	NA	7
EB056SW	East Branch	Post-survey	2.836	8:56	24.5	23.7	3.4	NA	15
EK109SW	English Kills	Pre-survey	2.927	6:17	24.8	23.4	4.9	4.5	18
EK110SW	English Kills	Pre-survey	3.226	6:27	25.1	22.9	4.4	4.0	16
EK111SW	English Kills	Pre-survey	3.569	6:34	25.2	21.8	3.0	2.8	8
EK-LT-20150819-0644_1	English Kills	During Survey	3.465	6:44	25.2	22.3	2.9	2.5	8
EK-LT-20150819-0701_1	English Kills	During Survey	3.332	7:01	25.1	22.7	4.9	4.1	19
EK-LT-20150819-0710_1	English Kills	During Survey	3.323	7:10	25.1	22.7	4.8	4.2	22
EK-LT-20150819-0734_1	English Kills	During Survey	3.013	7:34	24.9	23.2	4.6	4.3	22
EK-LT-20150819-0822_1	English Kills	During Survey	3.491	8:22	25.2	22.3	3.5	3.2	5
EK109SW	English Kills	Post-survey	2.928	8:53	24.7	23.4	5.1	4.8	19
EK110SW	English Kills	Post-survey	3.226	8:45	25.1	22.9	4.8	4.6	15
EK111SW	English Kills	Post-survey	3.568	8:37	25.1	22.0	3.2	2.8	8

Notes:
Calculated water depth is the water depth (feet) at the time of collection and is calculated from tide gauge height and Phase 2 bathymetry.
The creek mile associated with a surface water quality measurement collected in conjunction with a gas ebullition or sheen observation reflects the centerpoint of the gas ebullition or sheen observation area.

Acronyms:
CM = creek mile
NA = not available (measurement not recorded)
psu = practical salinity unit

Table D3-4
Summary of Environmental Conditions at the Time of Survey

Observation Area ID	Survey Event	Wind Direction	Wind Intensity	Weather	Wave Height (feet)	Wave Action	Vessel Traffic	Vessel Traffic Description
DK-HT-20150818-1130_1	HT	W	Light	Sunny	0.0	Calm	No	None
DK-HT-20150818-1135_1	HT	W	Light	Sunny	0.0	Calm	No	None
DK-HT-20150818-1200_1	HT	W	Light	Sunny	0.0	Calm	No	None
DK-HT-20150818-1230_1	HT	W	Light	Sunny	0.0	Calm	No	None
DK-HT-20150818-1330_1	HT	W	Light	Sunny	0.0	Calm	No	None
DK-HT-20150818-1345_1	HT	W	Light	Sunny	0.0	Calm	No	None
CM160194-HT-20150818-1214_1	HT	NA	Light	Sunny	NA	Calm	No	None
TB-HT-20150818-1231_1	HT	S	Light	Sunny	0.0	Calm	No	None
TB-HT-20150818-1301_1	HT	S	Light	Sunny	0.0	Calm	No	None
TB-HT-20150818-1411_1	HT	S	Light	Sunny	0.0	Slight	No	None
TB-HT-20150818-1421_1	HT	S	Light	Sunny	0.0	Slight	No	None
MC-HT-20150818-1230_1	HT	NA	Light	Sunny	0.0	Calm	No	None
MC-HT-20150818-1300_1	HT	E	Light	Sunny	0.2	Slight	No	None
EB-HT-20150818-1455_1	HT	NA	NA	Sunny	0.0	Calm	No	None
EB-HT-20150818-1455_2	HT	NA	NA	Sunny	0.0	Calm	No	None
EB-HT-20150818-1519_1	HT	SE	Light	Sunny	0.0	Calm	No	None
EK-HT-20150818-1155_1	HT	SW	Light	Sunny	0.0	Calm	No	None
EK-HT-20150818-1232_1	HT	SW	Light	Sunny	0.0	Calm	No	None
EK-HT-20150818-1310_1	HT	SW	Light	Sunny	0.0	Calm	No	None
EK-HT-20150818-1322_1	HT	SW	Light	Sunny	0.0	Calm	No	None
EK-HT-20150818-1352_1	HT	SW	Light	Sunny	0.0	Calm	No	None
EK-HT-20150818-1404_1	HT	NA	NA	Sunny	0.0	Calm	No	None
EK-HT-20150818-1418_1	HT	SW	Light	Sunny	0.0	Calm	No	None
DK-LT-20150818-1734_1	LT1	NA	NA	Sunny	0.0	Calm	No	None
DK-LT-20150818-1734_2	LT1	NA	NA	Sunny	0.0	Calm	No	None
DK-LT-20150818-1753_1	LT1	S	Light	Sunny	0.0	Calm	No	None
DK-LT-20150818-1753_2	LT1	S	Light	Sunny	0.0	Calm	No	None
DK-LT-20150818-1806_1	LT1	S	Light	Sunny	0.0	Calm	No	None

Table D3-4
Summary of Environmental Conditions at the Time of Survey

Observation Area ID	Survey Event	Wind Direction	Wind Intensity	Weather	Wave Height (feet)	Wave Action	Vessel Traffic	Vessel Traffic Description
DK-LT-20150818-1814_1	LT1	S	Light	Sunny	0.0	Calm	No	None
CM160194-LT-20150818-1810_1	LT1	S	Light	Sunny	0.0	Slight	No	None
CM160194-LT-20150818-1825_1	LT1	S	Light	Sunny	0.2	Slight	No	None
CM160194-LT-20150818-1852_1	LT1	N	Light	Sunny	0.2	Slight	No	None
MC-LT-20150818-1703_1	LT1	W	Light	Sunny	0.0	Calm	No	None
MC-LT-20150818-1703_2	LT1	W	Light	Sunny	0.0	Calm	No	None
EB-LT-20150818-1753_1	LT1	W	Light	Sunny	0.0	Slight	No	None
EB-LT-20150818-1837_1	LT1	W	Light	Sunny	0.0	Slight	No	None
EB-LT-20150818-1837_2	LT1	W	Light	Sunny	0.0	Slight	No	None
EK-LT-20150818-1648_1	LT1	NA	Light	Sunny	0.1	Slight	Yes	Moored barge
EK-LT-20150818-1825_1	LT1	NA	Light	Sunny	0.0	Calm	No	None
EK-LT-20150818-1825_2	LT1	NA	Light	Sunny	0.0	Calm	No	None
EK-LT-20150818-1849_1	LT1	NA	Light	Sunny	0.0	Calm	No	None
CM019050-LT-20150819-0833_1	LT2	SE	Light	Sunny	0.0	NA	No	None
CM067083-LT-20150819-0910_1	LT2	SE	Light	Sunny	0.0	Calm	No	None
DK-LT-20150819-0620_1	LT2	SW	Light	Cloudy	0.3	Slight	No	None
DK-LT-20150819-0640_1	LT2	NA	Light	Cloudy	0.0	Calm	No	None
DK-LT-20150819-0701_1	LT2	NA	Light	Cloudy	0.0	Calm	No	None
DK-LT-20150819-0714_1	LT2	NA	Light	NA	0.1	Calm	No	None
CM090136-LT-20150819-0601_1	LT2	E	Light	Sunny	0.0	Calm	No	None
CM090136-LT-20150819-0619_1	LT2	E	Light	Sunny	0.0	Calm	No	None
CM090136-LT-20150819-0642_1	LT2	SE	Light	Sunny	0.0	Calm	No	None
CM090136-LT-20150819-0642_2	LT2	SE	Light	Sunny	0.0	Calm	No	None
CM090136-LT-20150819-0659_1	LT2	S	Light	Sunny	0.0	Calm	No	None
CM090136-LT-20150819-0659_2	LT2	S	Light	Sunny	0.0	Calm	No	None
CM090136-LT-20150819-0715_1	LT2	SE	Light	Sunny	0.0	Calm	No	None
CM160194-LT-20150819-0752_1	LT2	SE	Light	Sunny	0.0	Calm	No	None
CM160194-LT-20150819-0752_2	LT2	SE	Light	Sunny	0.0	Calm	No	None

Table D3-4
Summary of Environmental Conditions at the Time of Survey

Observation Area ID	Survey Event	Wind Direction	Wind Intensity	Weather	Wave Height (feet)	Wave Action	Vessel Traffic	Vessel Traffic Description
TB-LT-20150819-0637_1	LT2	W	Light	Cloudy	0.0	Slight	No	None
TB-LT-20150819-0637_2	LT2	W	Light	Cloudy	0.0	Slight	No	None
TB-LT-20150819-0637_3	LT2	W	Light	Cloudy	0.0	Slight	No	None
TB-LT-20150819-0637_4	LT2	W	Light	Cloudy	0.0	Slight	No	None
TB-LT-20150819-0637_5	LT2	W	Light	Cloudy	0.0	Slight	No	None
TB-LT-20150819-0713_1	LT2	SW	Light	Cloudy	0.0	Slight	No	None
TB-LT-20150819-0735_1	LT2	SW	Light	NA	0.0	Calm	No	None
TB-LT-20150819-0821_1	LT2	SW	Light	Cloudy	0.0	Calm	No	None
MC-LT-20150819-0610_1	LT2	NA	Light	Cloudy	0.0	Calm	No	None
MC-LT-20150819-0658_1	LT2	NA	Light	Cloudy	NA	Calm	No	None
EB-LT-20150819-0740_1	LT2	NA	Light	Cloudy	0.0	Calm	No	None
EB-LT-20150819-0802_1	LT2	NA	Light	Cloudy	0.0	Calm	No	None
EB-LT-20150819-0811_1	LT2	NA	Light	Cloudy	0.0	Calm	No	None
EK-LT-20150819-0644_1	LT2	NA	Light	Cloudy	0.0	Calm	No	None
EK-LT-20150819-0701_1	LT2	NA	Light	Cloudy	0.0	Calm	Yes	Moored barge
EK-LT-20150819-0710_1	LT2	NA	Light	Cloudy	0.0	Calm	No	None
EK-LT-20150819-0726_1	LT2	NA	Light	Cloudy	0.0	Calm	Yes	Moored barge
EK-LT-20150819-0734_1	LT2	NA	Light	Cloudy	0.0	Calm	Yes	Moored barge
EK-LT-20150819-0742_1	LT2	NA	Light	Cloudy	0.0	Calm	Yes	Moored barge
EK-LT-20150819-0809_1	LT2	NA	Light	Cloudy	0.0	Calm	No	None
EK-LT-20150819-0822_1	LT2	NA	Light	Cloudy	0.0	Calm	No	None

Acronyms:
E = east
HT = High Tide Survey No. 1, conducted on August 18, 2015
LT1 = Low Tide Survey No. 1, conducted on August 18, 2015
LT2 = Low Tide Survey No. 2, conducted on August 19, 2015
N = north
NA = not available (measurement not recorded)
S = south
SE = southeast
SW = southwest
W = west

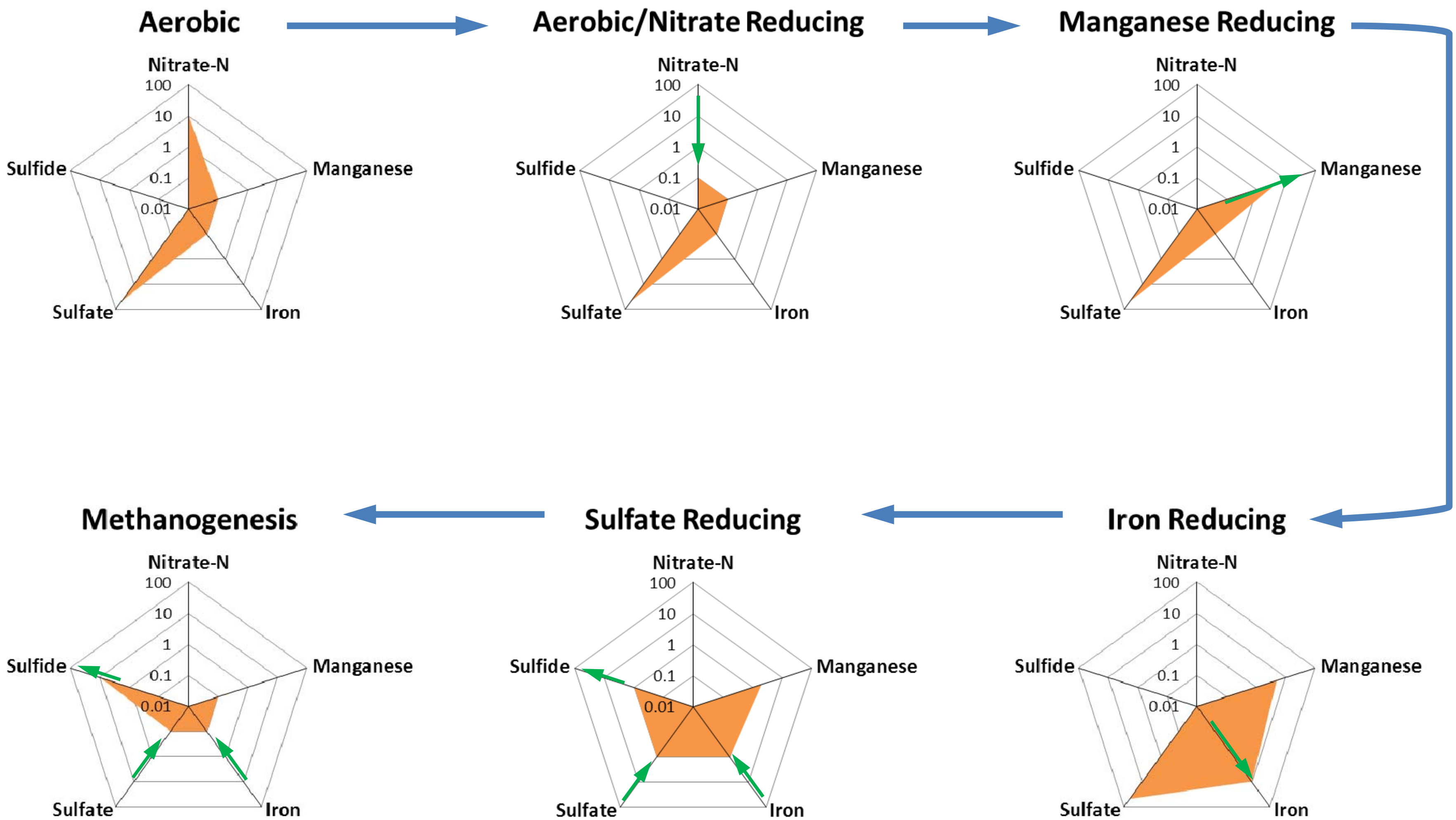
Table D3-5
Average Weather Conditions at the Time of Survey

Field Ebullition Survey	Air Temperature (°C)	Barometric Pressure (inches of mercury)	Wind Speed (mph)	Wind Direction (degrees)
High Tide Survey No. 1	30.4	30.02	7.4	196
Low Tide Survey No. 1	27.3	29.98	9.5	217
Low Tide Survey No. 2	25.2	30.04	4.5	212

Notes:
Data obtained from Greenpoint Energy Center weather station were averaged over the date and time period for each survey; average values are presented in this table.
High Tide Survey No. 1 and Low Tide Survey No. 1 conducted on August 18, 2015.
Low Tide Survey No. 2 conducted on August 19, 2015.
Survey times provided on Table D2-2.

Acronym:
mph = miles per hour

FIGURES



Note: Concentrations are conceptual in milligrams per liter. The figure was created based on compiled information from relevant sources (Chapelle 2001, Emerson and Hedges 2003, Salminen et al. 2006).

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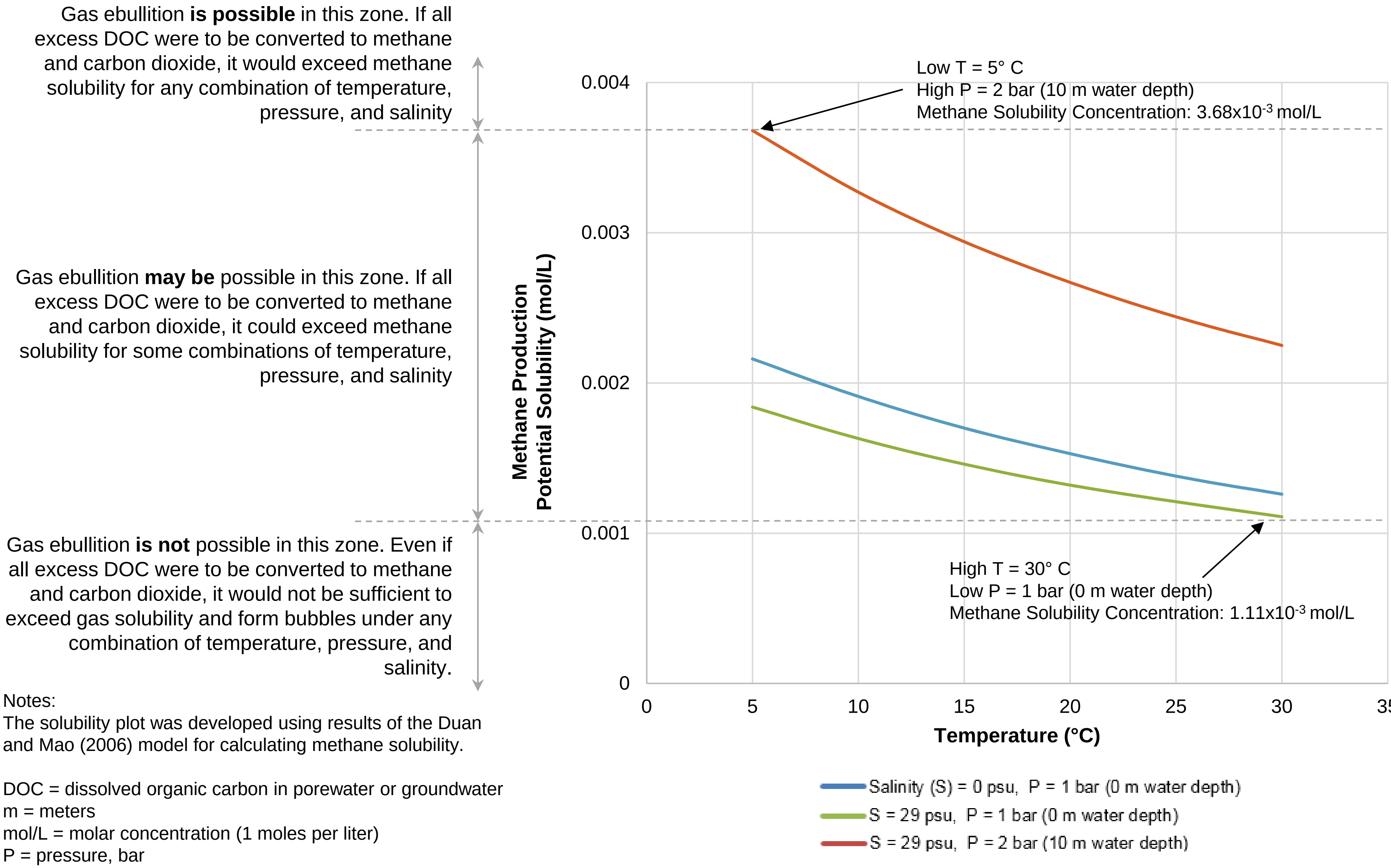
Figure D1-1
Electron Acceptor Utilization Pattern
Gas Ebullition Evaluation
Newtown Creek RI/FS



Notes:
The solubility plot was developed using results of the Duan and Mao (2006) model for calculating methane solubility.

DOC = dissolved organic carbon in porewater or groundwater
m = meters
mol/L = molar concentration (1 moles per liter)
P = pressure, bar
psu = practical salinity units
S = salinity, psu
T = temperature, degrees Celsius

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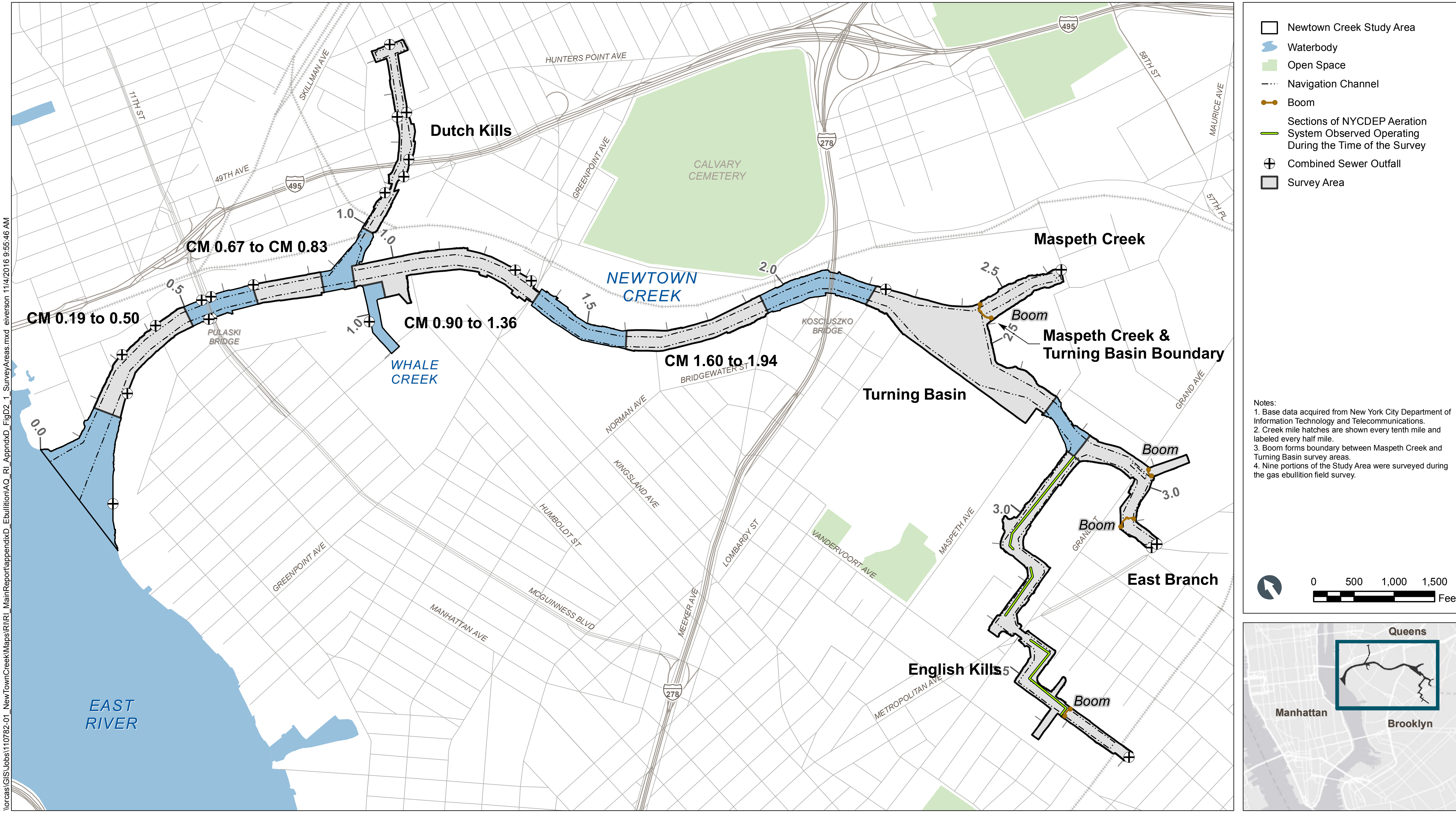
Figure D1-2
Methane Solubility versus Temperature and Pressure
Gas Ebullition Evaluation
Newtown Creek RI/FS



Notes:
1. Base data acquired from New York City Department of Information Technology and Telecommunications.
2. Creek mile hatches are shown every tenth mile and labeled every half mile.
3. Boom forms boundary between Maspeth Creek and Turning Basin survey areas.
4. Nine portions of the Study Area were surveyed during the gas ebullition field survey.

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Figure D2-1
Field Gas Ebullition Survey Areas – 2015
Gas Ebullition Evaluation
Newtown Creek RI/FS

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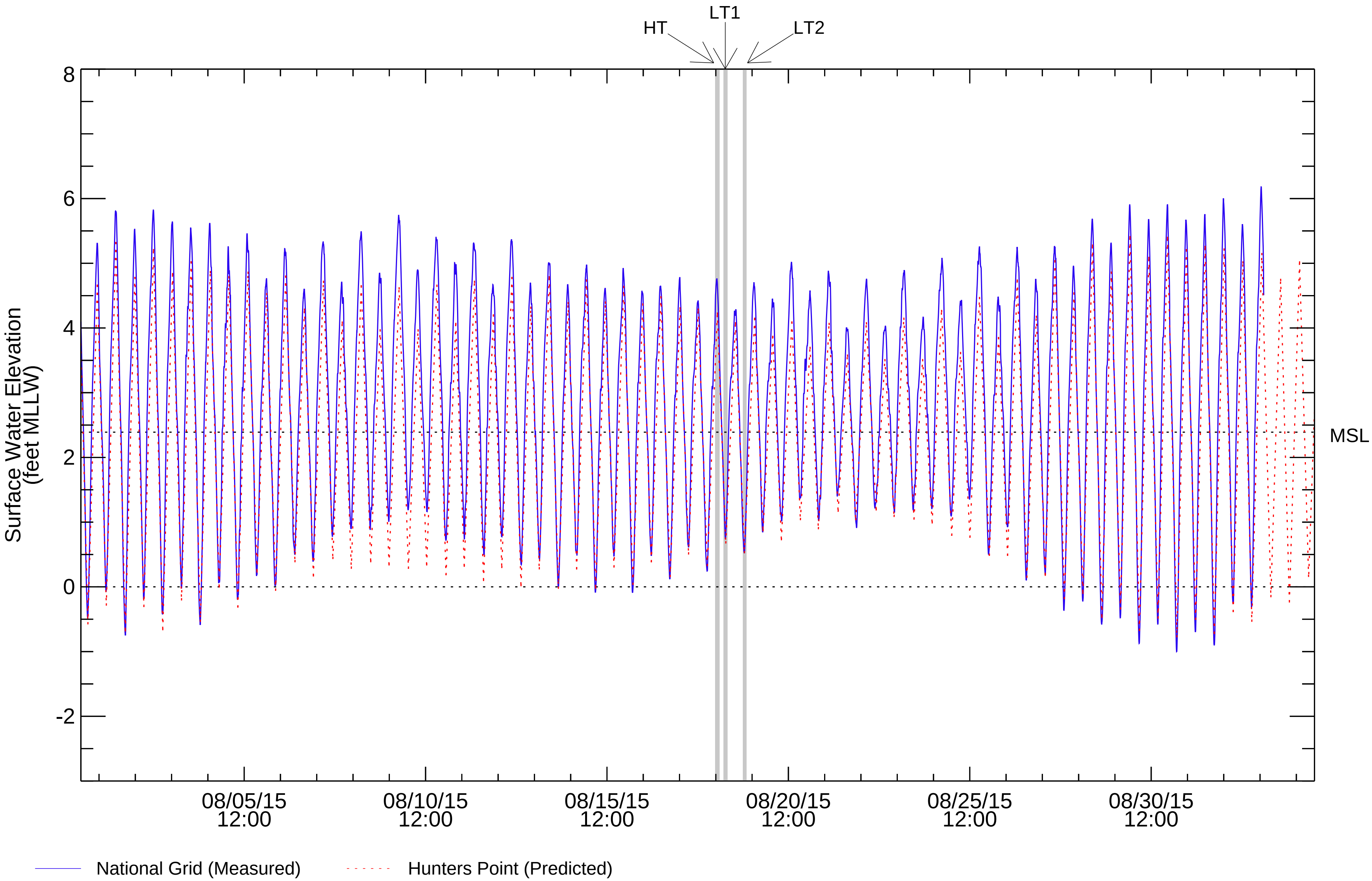

Figure D2-2

Surface Water Elevations during the Phase 2 Field Gas Ebullition Survey - 2015
Gas Ebullition Evaluation
Newtown Creek RI/FS

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Notes: Gas Ebullition Field Survey periods are shown in gray. Mean sea level (MSL) is 2.39 feet MLLW (mean lower low water). Measured tidal elevation data obtained from the Greenpoint Energy Center gauge, which stopped functioning on 9/2/2015. Estimated tidal elevation data obtained from National Oceanic and Atmospheric Administration (NOAA) for Hunters Point, Newtown Creek, NY. HT: High Tide Survey No. 1; LT1: Low Tide Survey No. 1; LT2: Low Tide Survey No. 2

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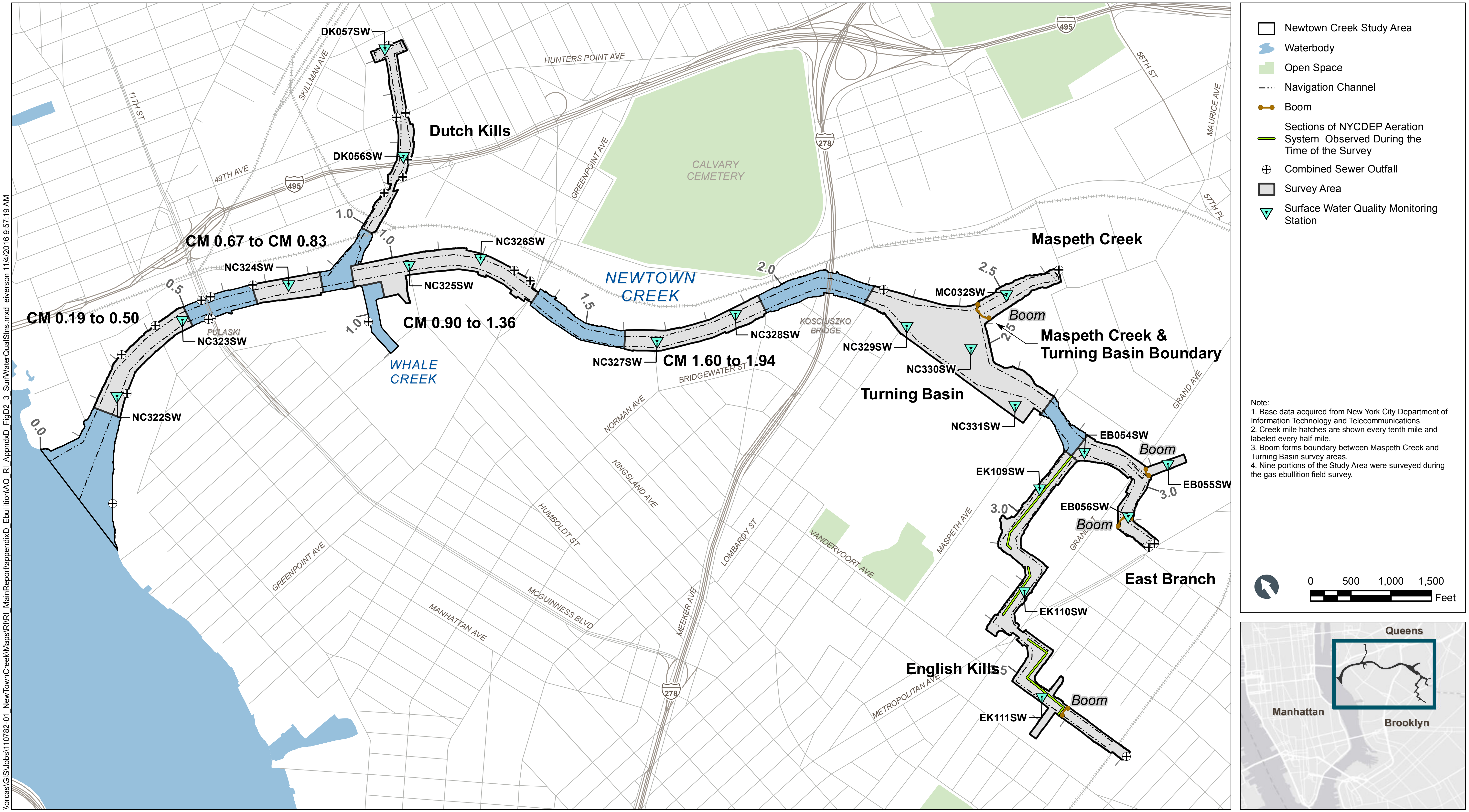

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Figure D2-3
Field Gas Ebullition Survey Surface Water Quality Monitoring Stations – 2015
Gas Ebullition Evaluation
Newtown Creek RI/FS

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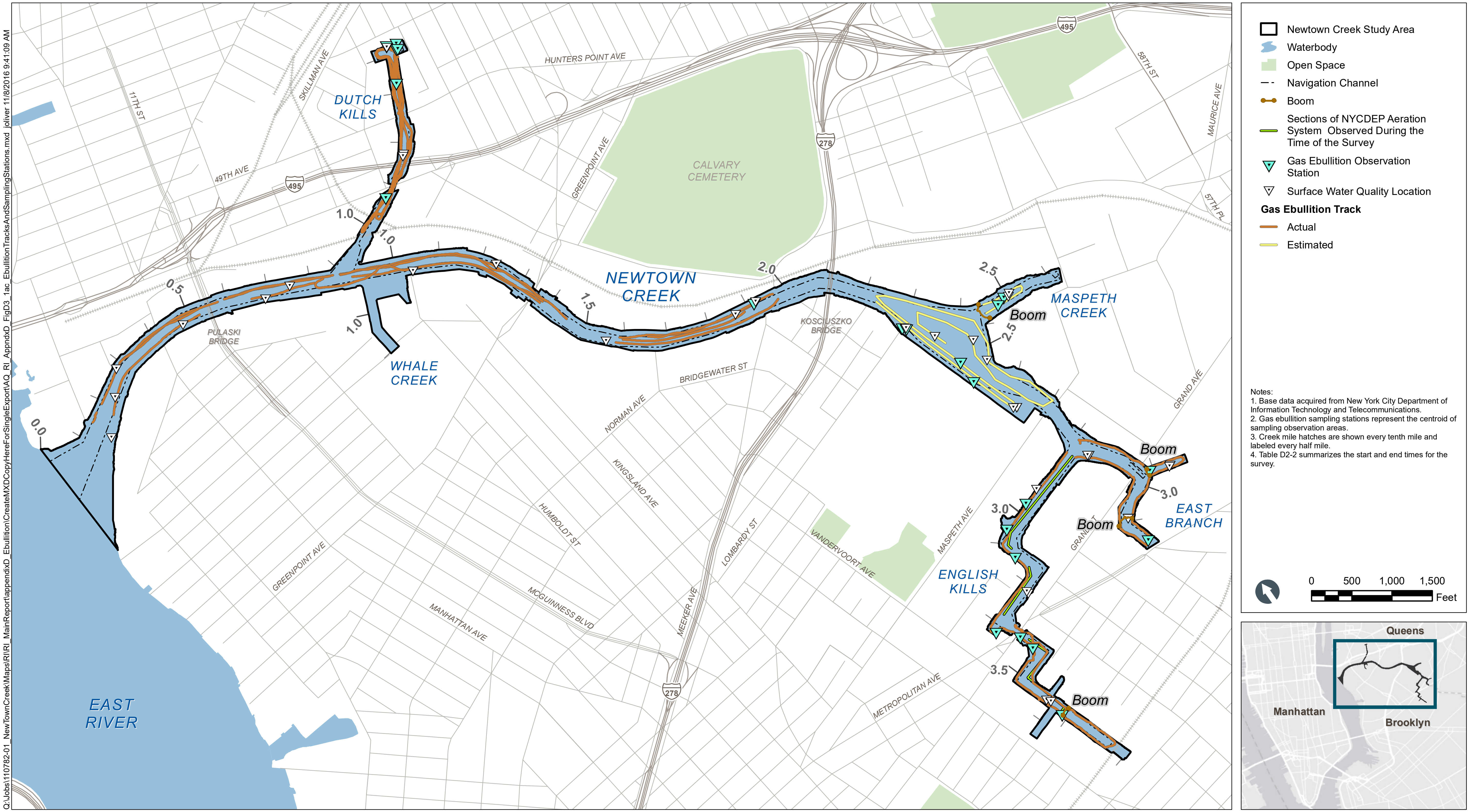

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Figure D3-1a
Field Gas Ebullition Survey Tracks and Stations – 2015 High Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS

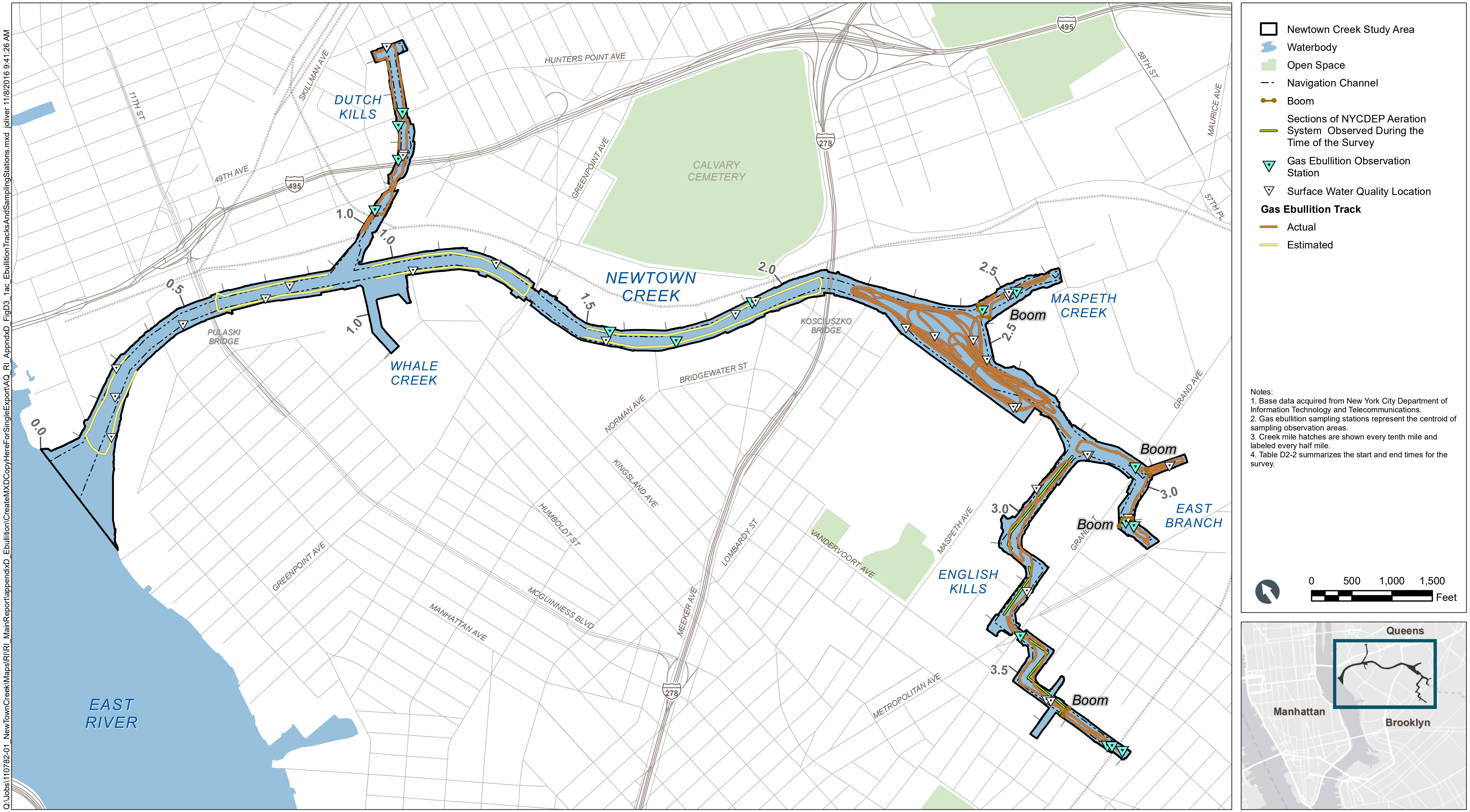

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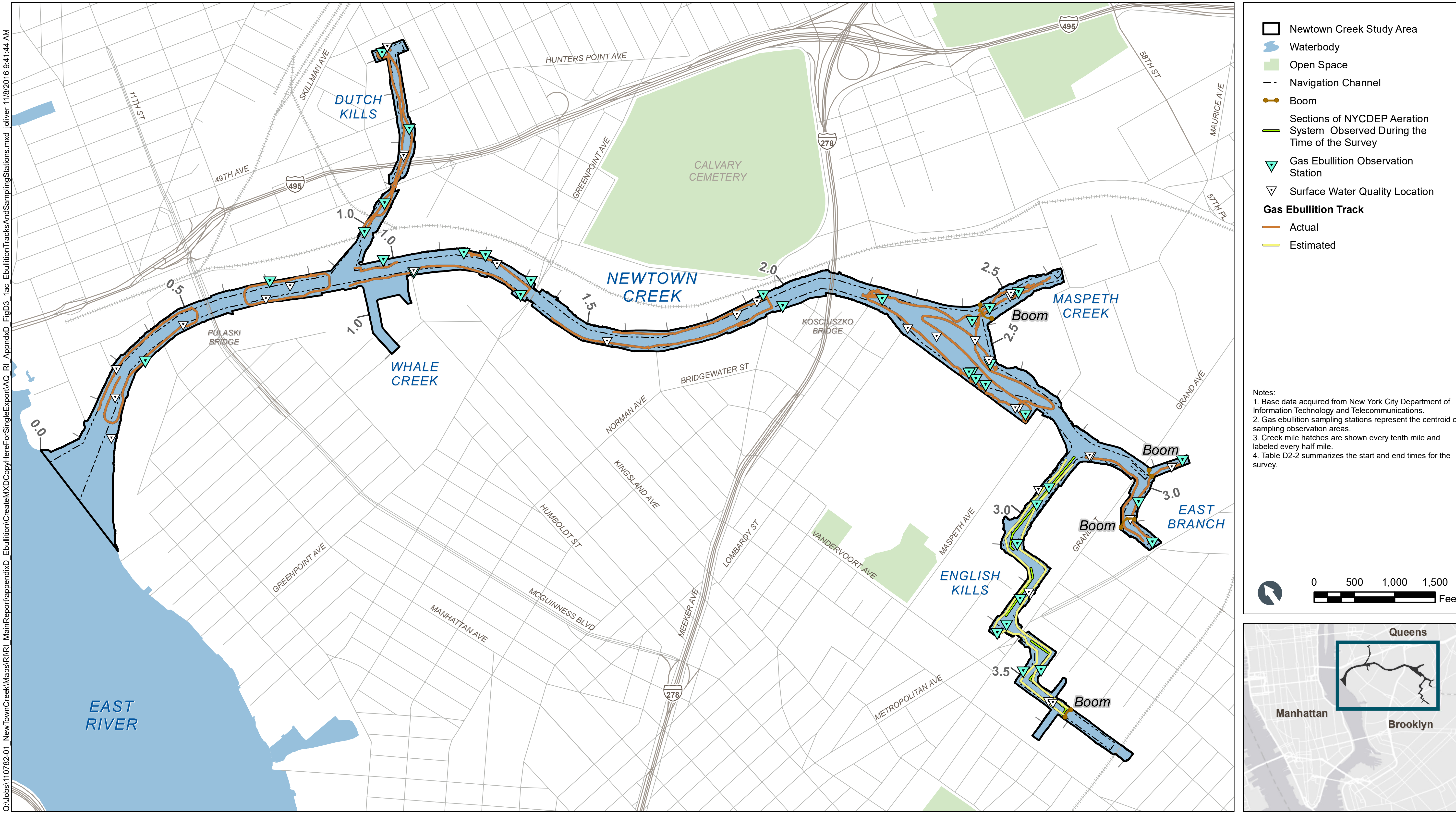
Figure D3-1b
Field Gas Ebullition Survey Tracks and Stations – 2015 Low Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS



Notes:
1. Base data acquired from New York City Department of Information Technology and Telecommunications.
2. Gas ebullition sampling stations represent the centroid of sampling observation areas.
3. Creek mile hatches are shown every tenth mile and labeled every half mile.
4. Table D2-2 summarizes the start and end times for the survey.

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Figure D3-1c
Field Gas Ebullition Survey Tracks and Stations – 2015 Low Tide Survey No. 2
Gas Ebullition Evaluation
Newtown Creek RI/FS

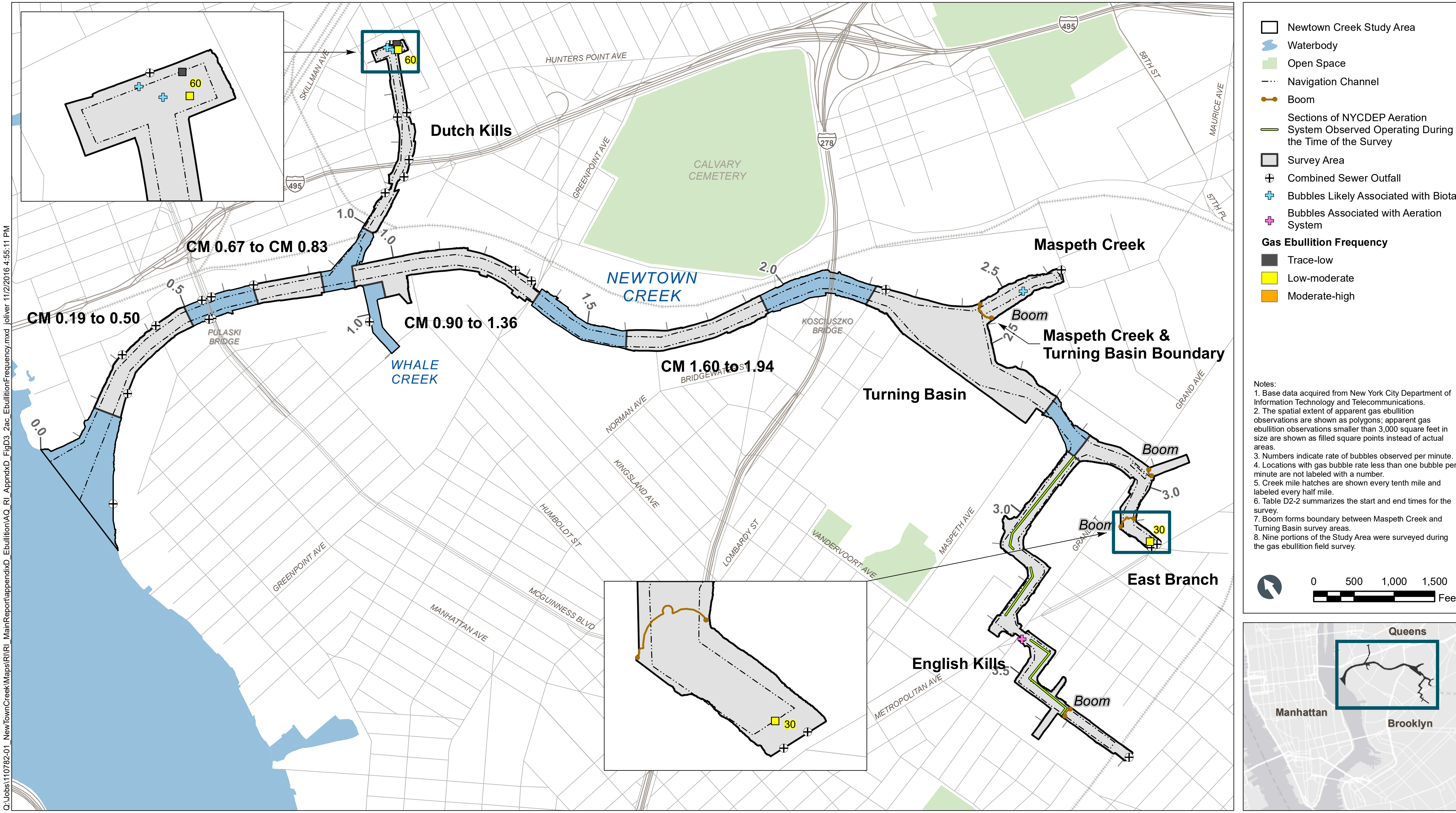

Figure D3-2a
Apparent Gas Ebullition Observations by Gas Bubble Frequency – 2015 High Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS

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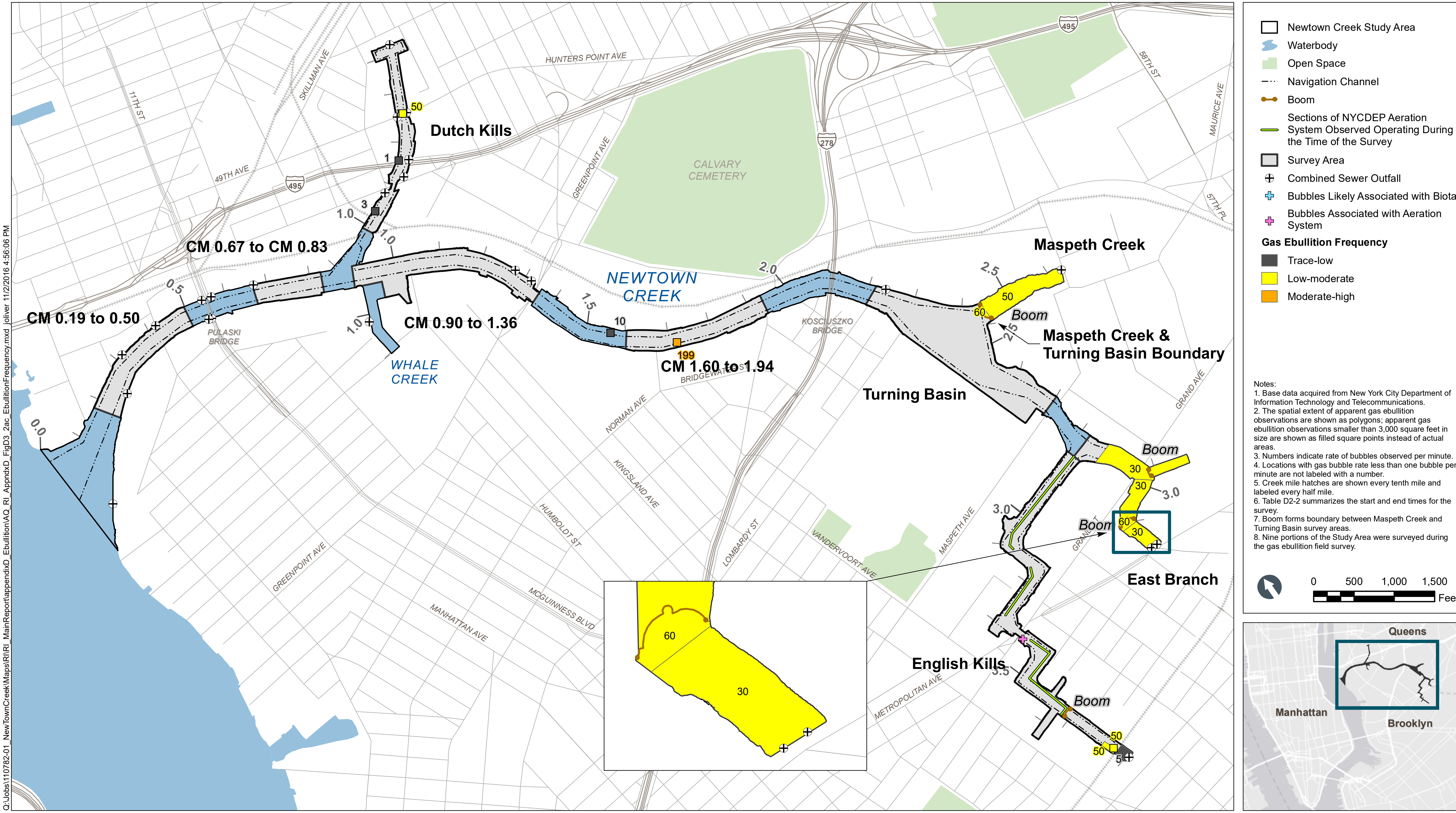

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Figure D3-2b
Apparent Gas Ebullition Observations by Gas Bubble Frequency – 2015 Low Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS

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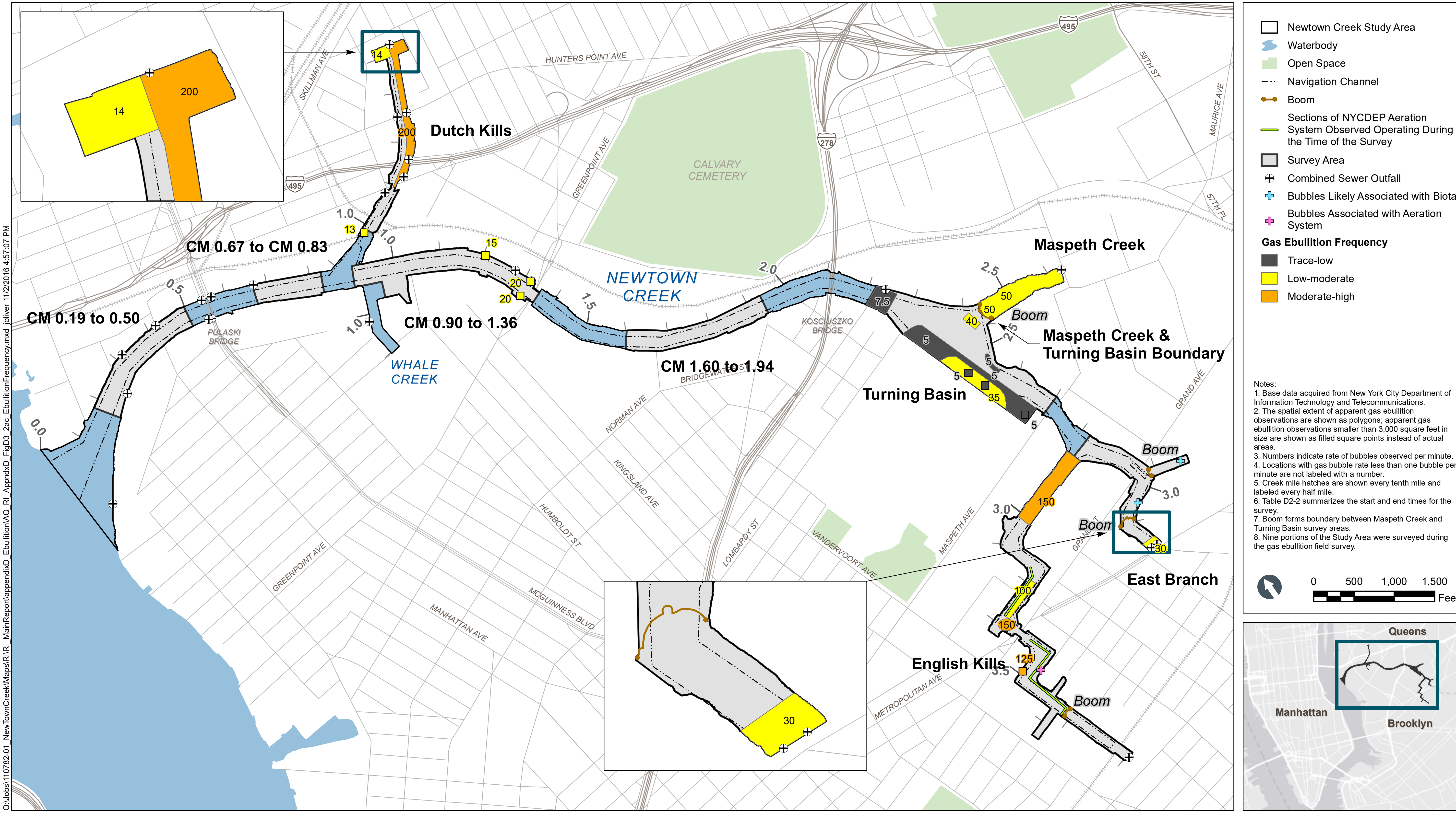

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Figure D3-2c
Apparent Gas Ebullition Observations by Gas Bubble Frequency – 2015 Low Tide Survey No. 2
Gas Ebullition Evaluation
Newtown Creek RI/FS

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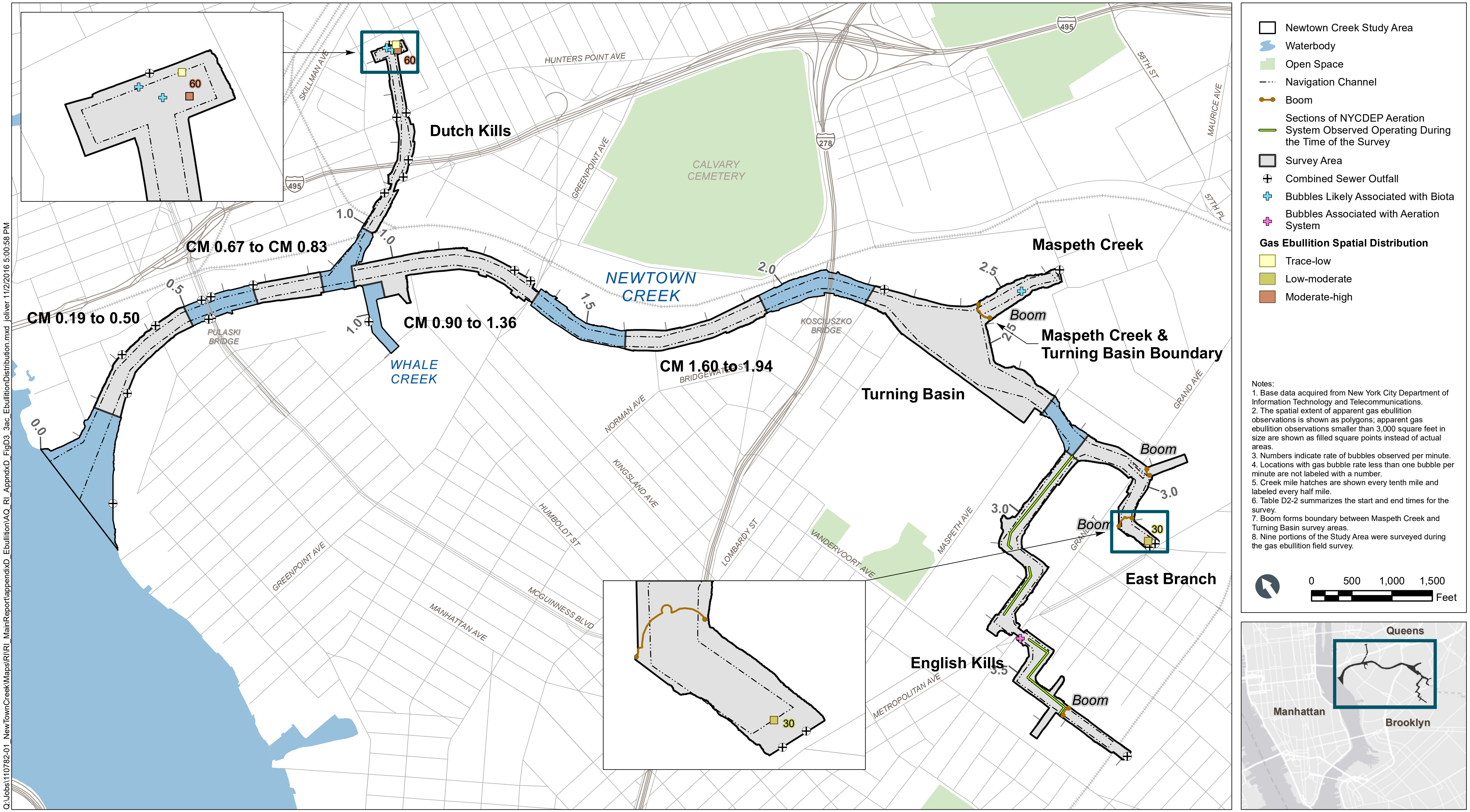

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Figure D3-3a
Apparent Gas Ebullition Observations by Gas Bubble Distribution – 2015 High Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS

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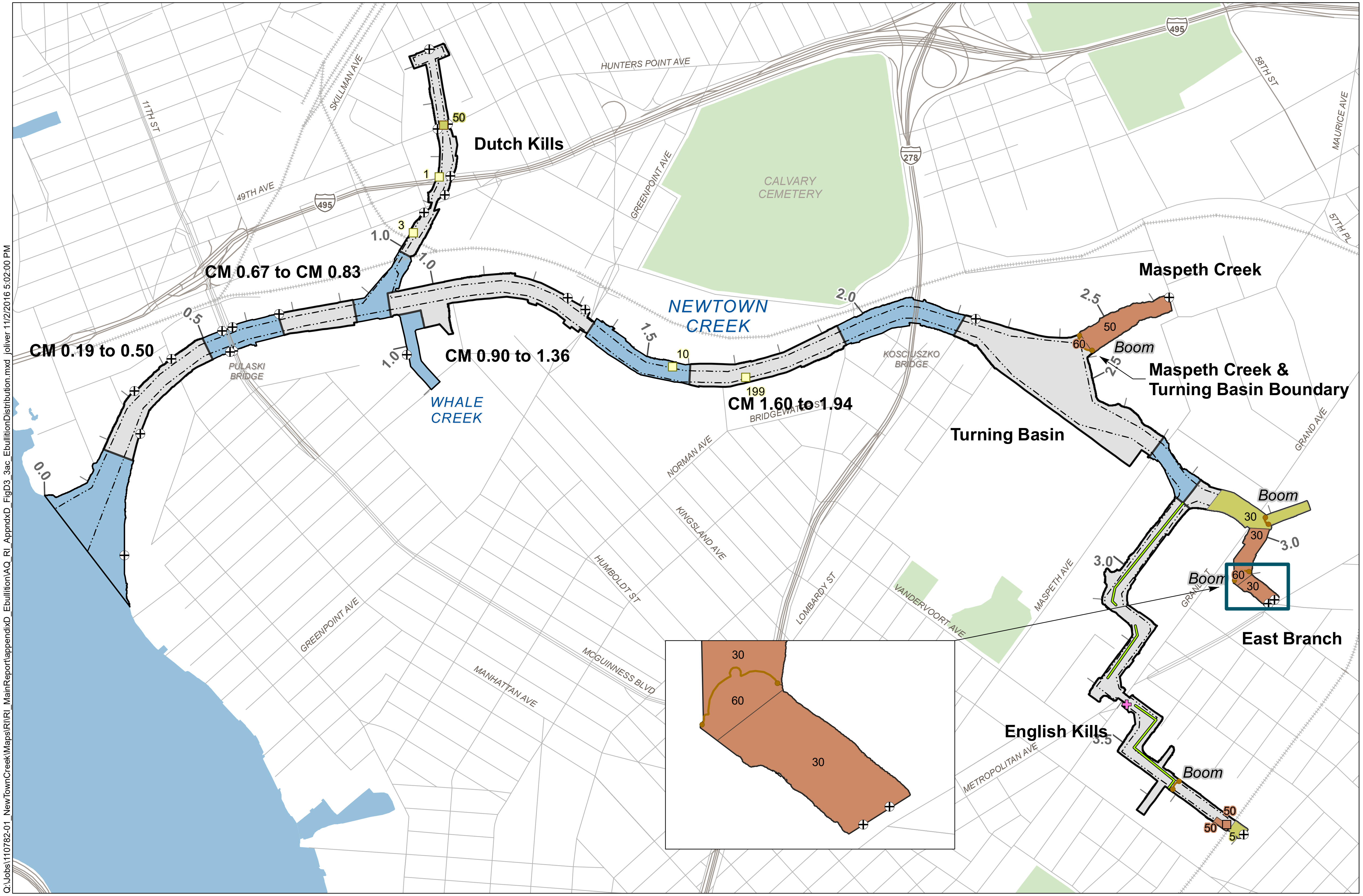

- Newtown Creek Study Area
- Waterbody
- Open Space
- Navigation Channel
- Boom
- Sections of NYCDEP Aeration System Observed Operating During the Time of the Survey
- Survey Area
- Combined Sewer Outfall
- Bubbles Likely Associated with Biota
- Bubbles Associated with Aeration System

Gas Ebullition Spatial Distribution

- Trace-low
- Low-moderate
- Moderate-high

Notes:
1. Base data acquired from New York City Department of Information Technology and Telecommunications.
2. The spatial extent of apparent gas ebullition observations is shown as polygons; apparent gas ebullition observations smaller than 3,000 square feet in size are shown as filled square points instead of actual areas.
3. Numbers indicate rate of bubbles observed per minute.
4. Locations with gas bubble rate less than one bubble per minute are not labeled with a number.
5. Creek mile hatches are shown every tenth mile and labeled every half mile.
6. Table D2-2 summarizes the start and end times for the survey.
7. Boom forms boundary between Maspeth Creek and Turning Basin survey areas.
8. Nine portions of the Study Area were surveyed during the gas ebullition field survey.

0 500 1,000 1,500 Feet

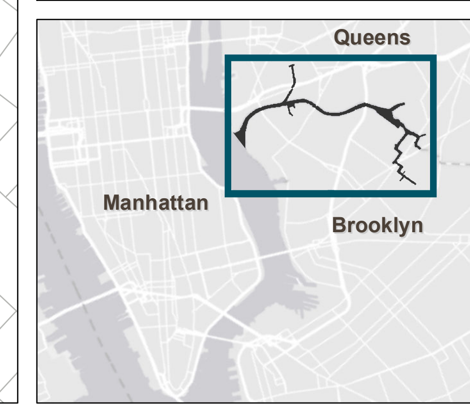

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Figure D3-3b
Apparent Gas Ebullition Observations by Gas Bubble Distribution – 2015 Low Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS

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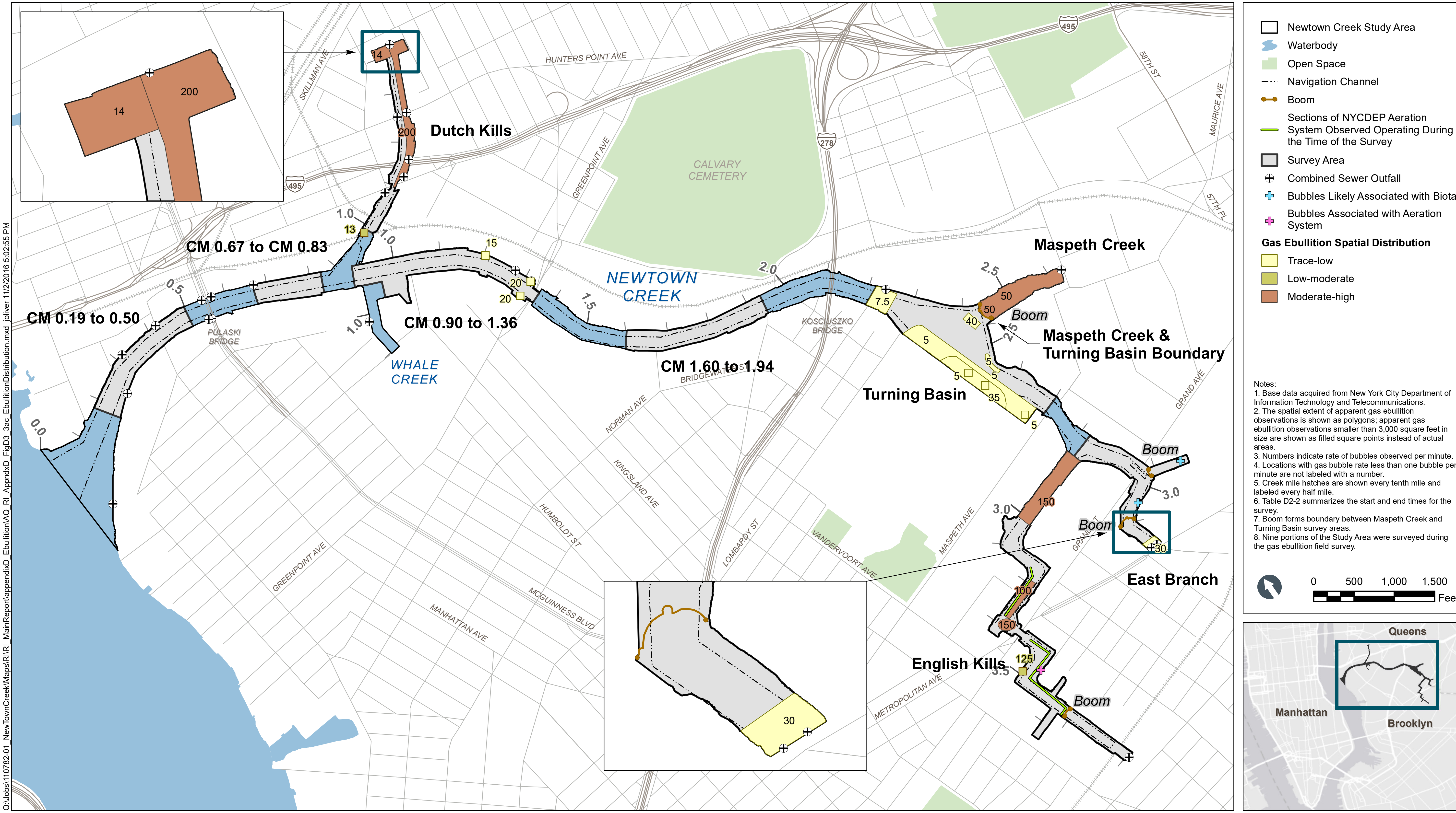

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Figure D3-3c
Apparent Gas Ebullition Observations by Gas Bubble Distribution – 2015 Low Tide Survey No. 2
Gas Ebullition Evaluation
Newtown Creek RI/FS

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English Kills Survey Area
Moderate to high bubble frequency (50 bubbles per minute)

English Kills Survey Area
Gas bubbles associated with aeration system operation

CM 1.6 to 1.94 Survey Area
Moderate to high bubble frequency (199 bubbles per minute)

Maspeth Creek Survey Area
Low to moderate bubble frequency (10 bubbles per minute)

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Figure D3-4
Examples of Representative Apparent Gas Ebullition Observations
Gas Ebullition Evaluation
Newtown Creek RI/FS

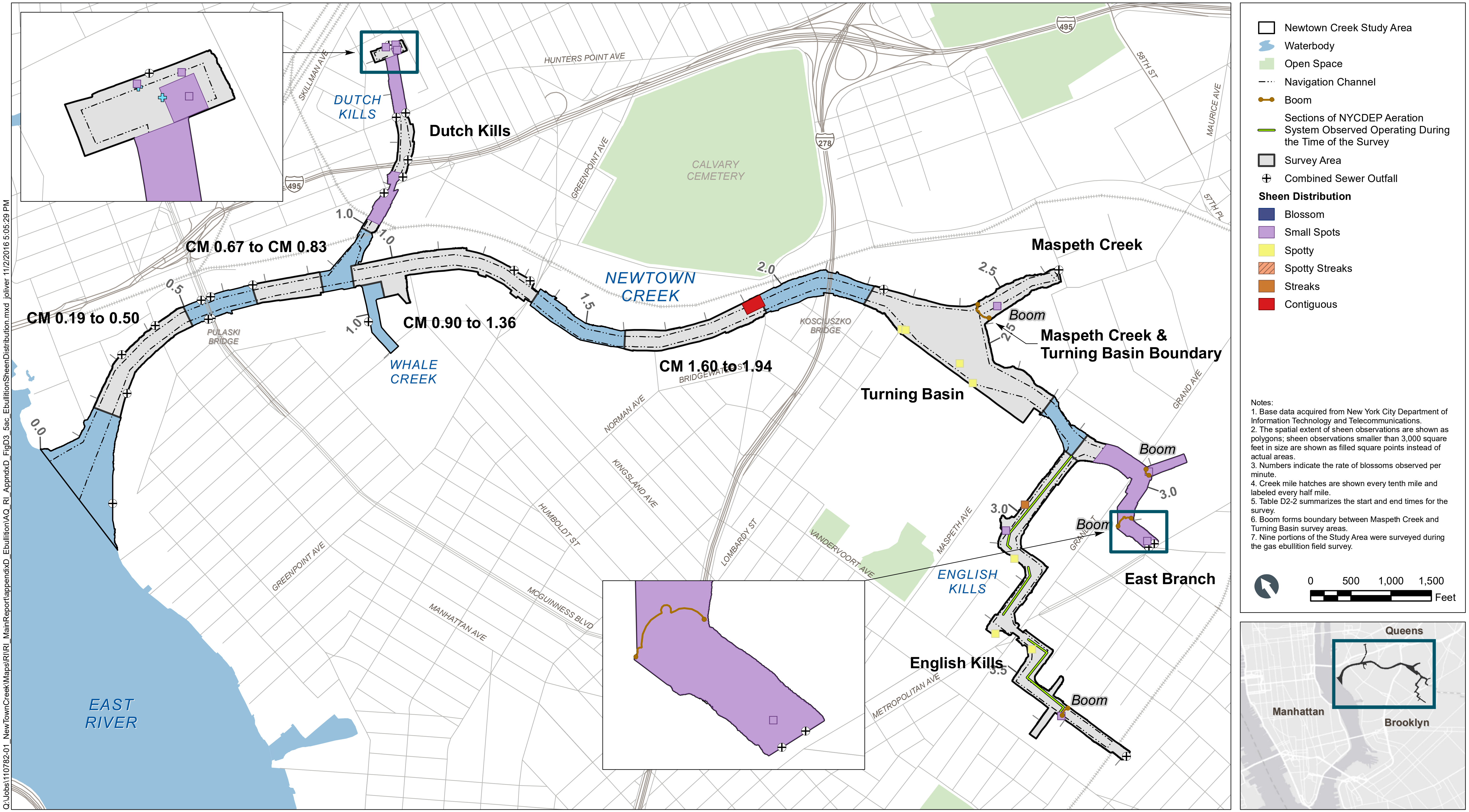

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Figure D3-5a
Sheen Observations by Sheen Distribution – 2015 High Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS

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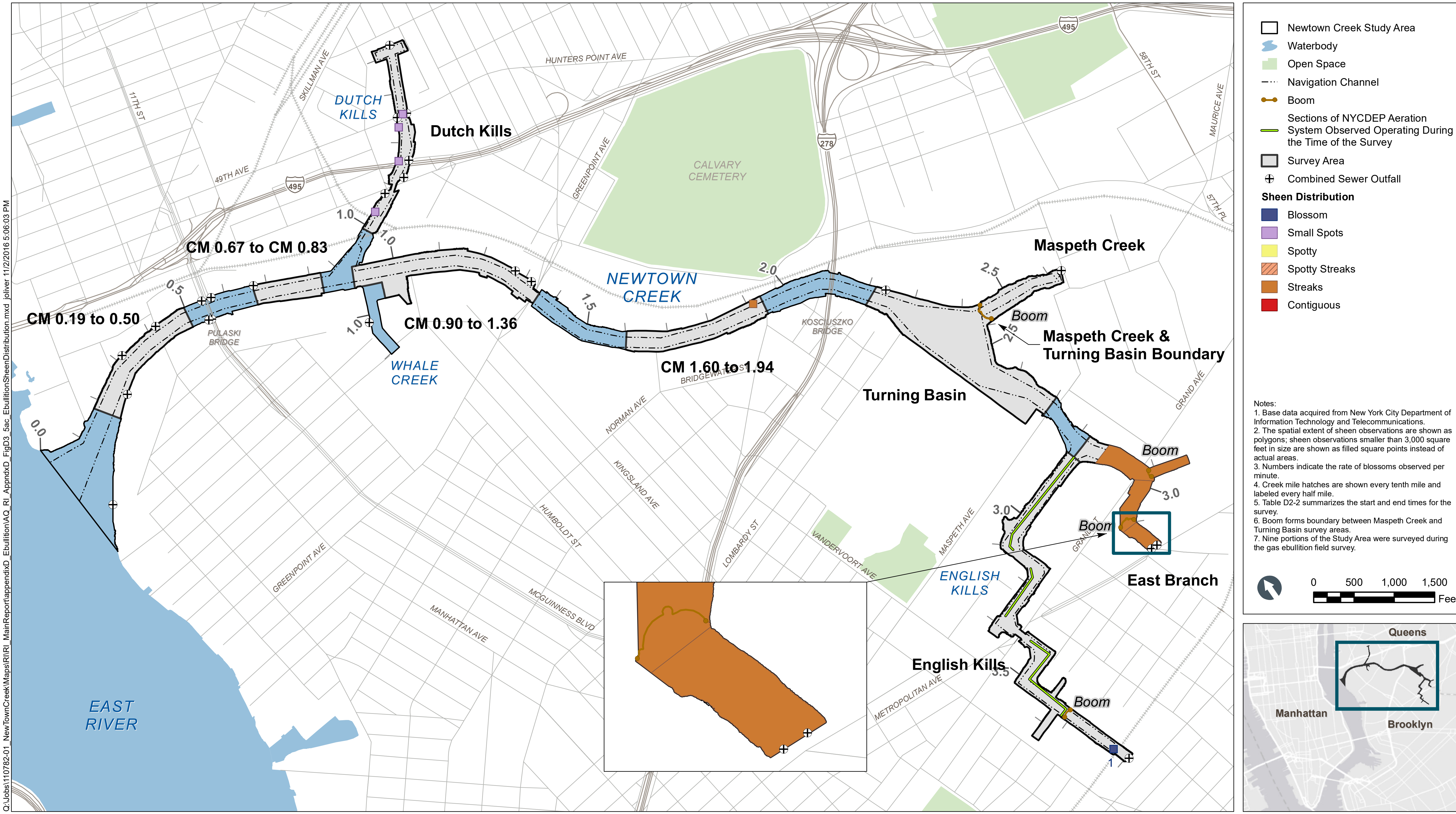

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Figure D3-5b
Sheen Observations by Sheen Distribution – 2015 Low Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS

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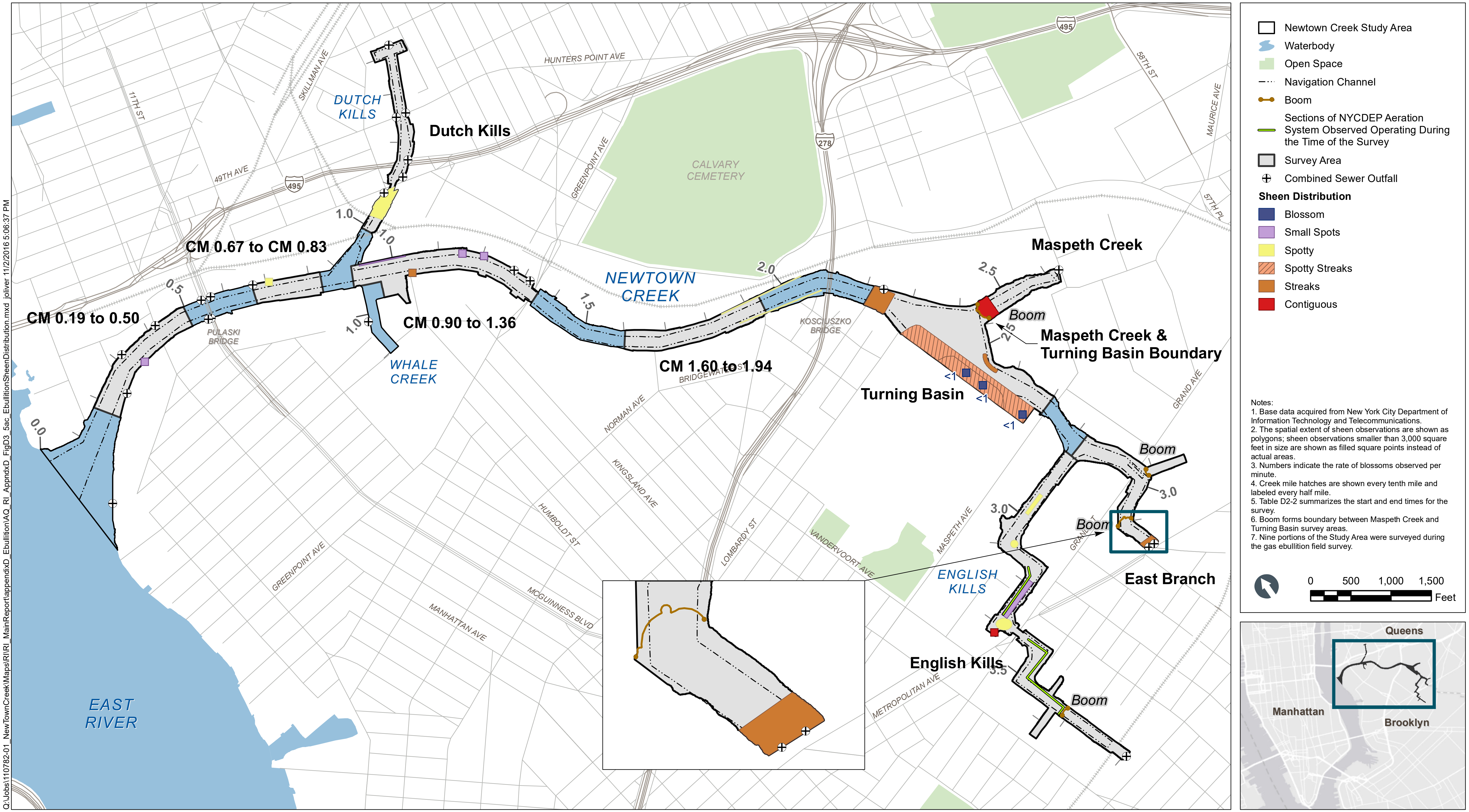

Figure D3-5c
Sheen Observations by Sheen Distribution – 2015 Low Tide Survey No. 2
Gas Ebullition Evaluation
Newtown Creek RI/FS

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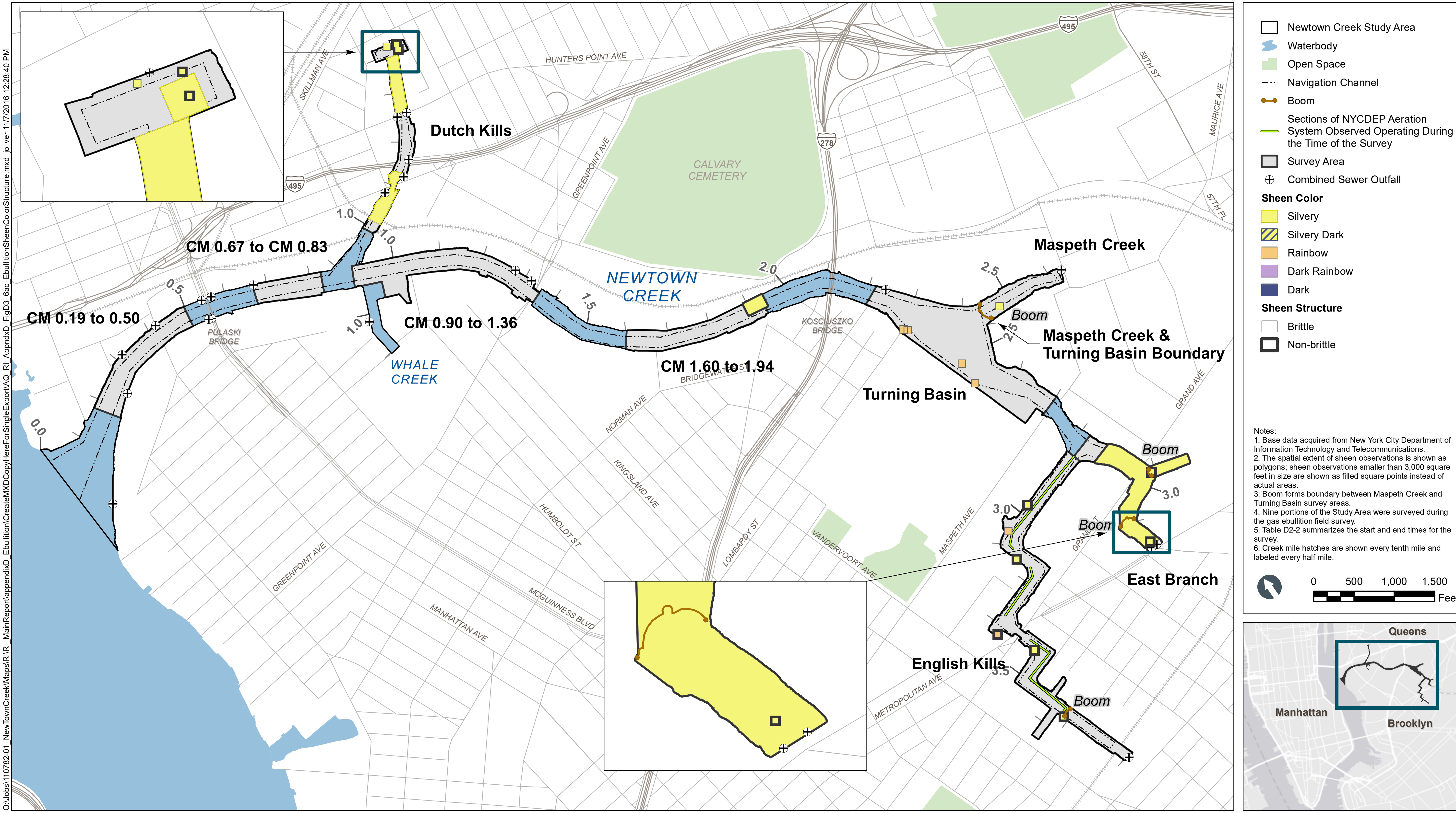

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Figure D3-6a
Sheen Observations by Sheen Color and Structure – 2015 High Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS

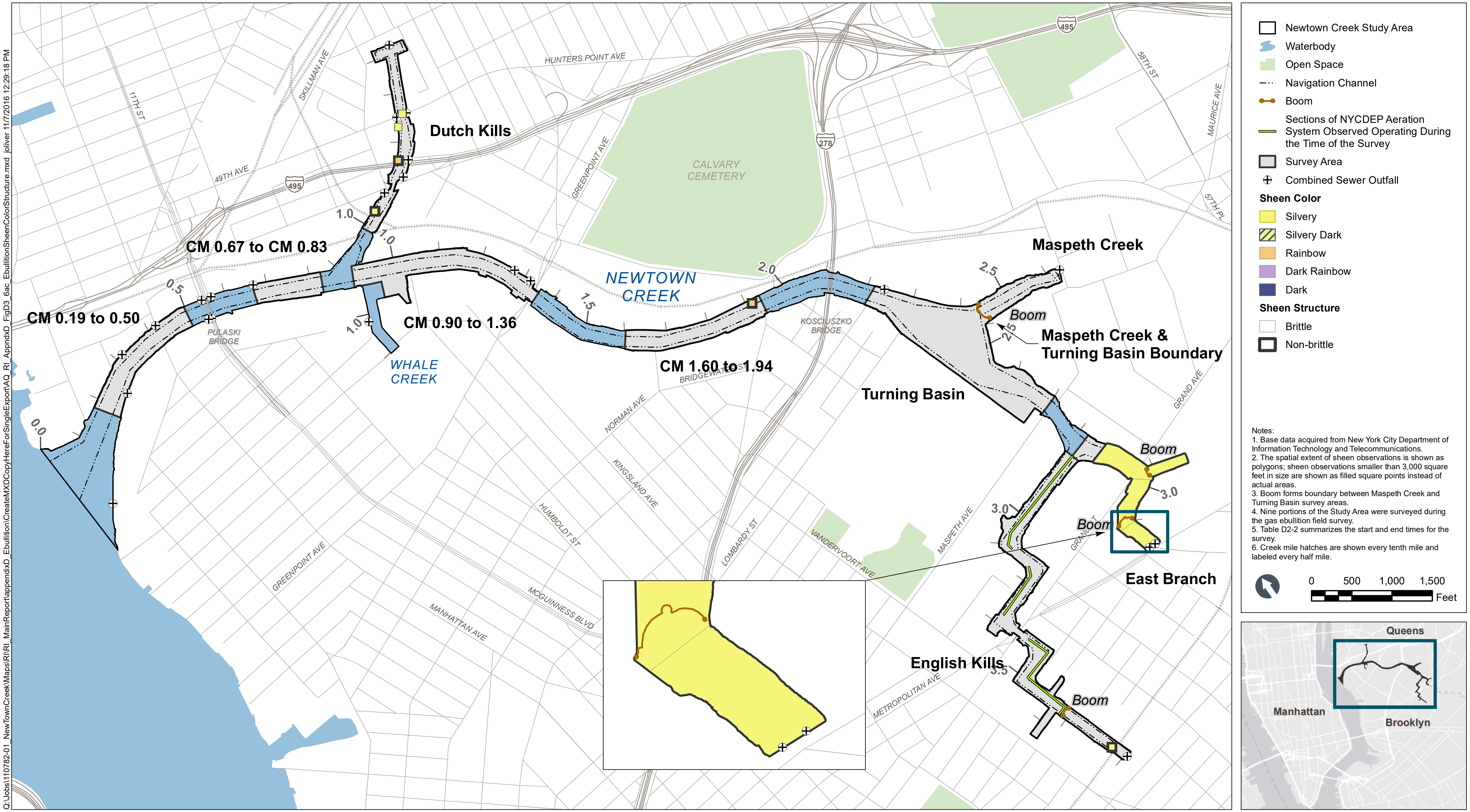

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Figure D3-6b
Sheen Observations by Sheen Color and Structure – 2015 Low Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS

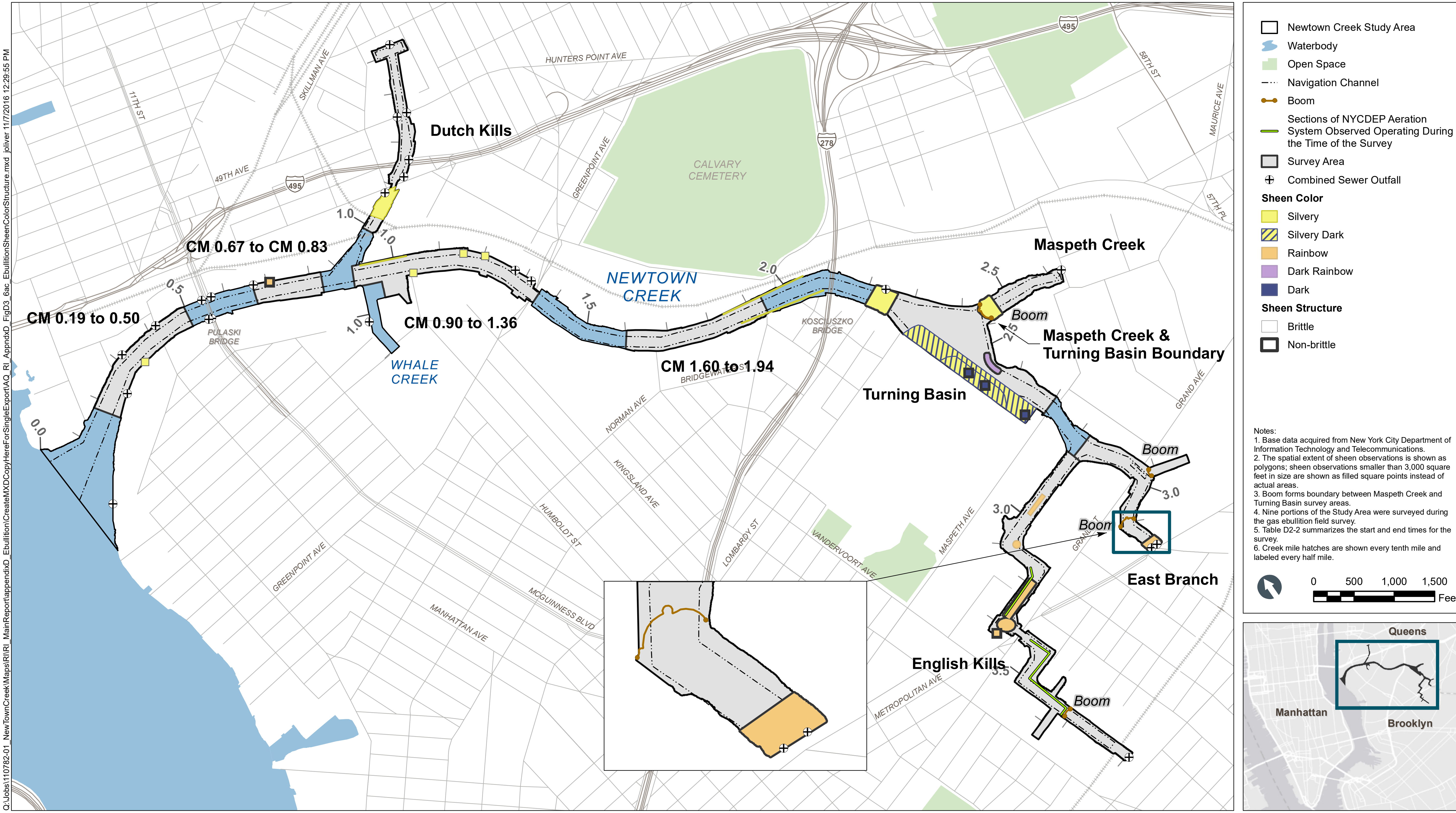

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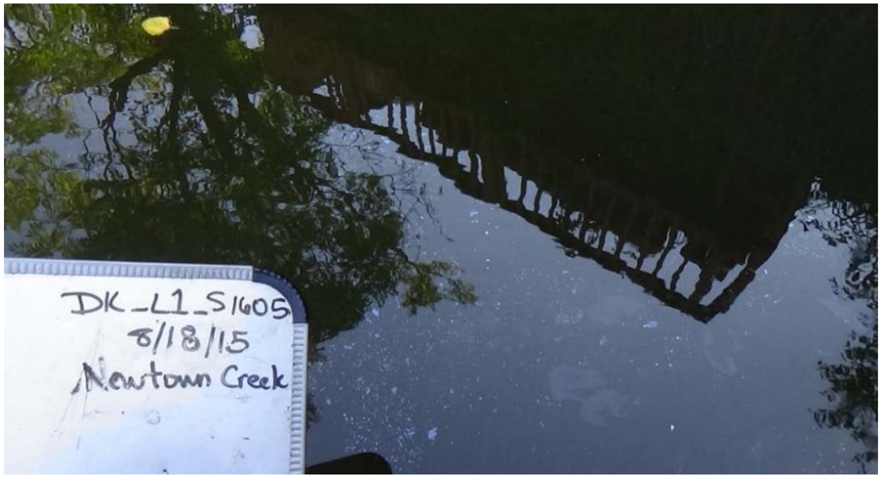
Figure D3-6c
Sheen Observations by Sheen Color and Structure – 2015 Low Tide Survey No. 2
Gas Ebullition Evaluation
Newtown Creek RI/FS

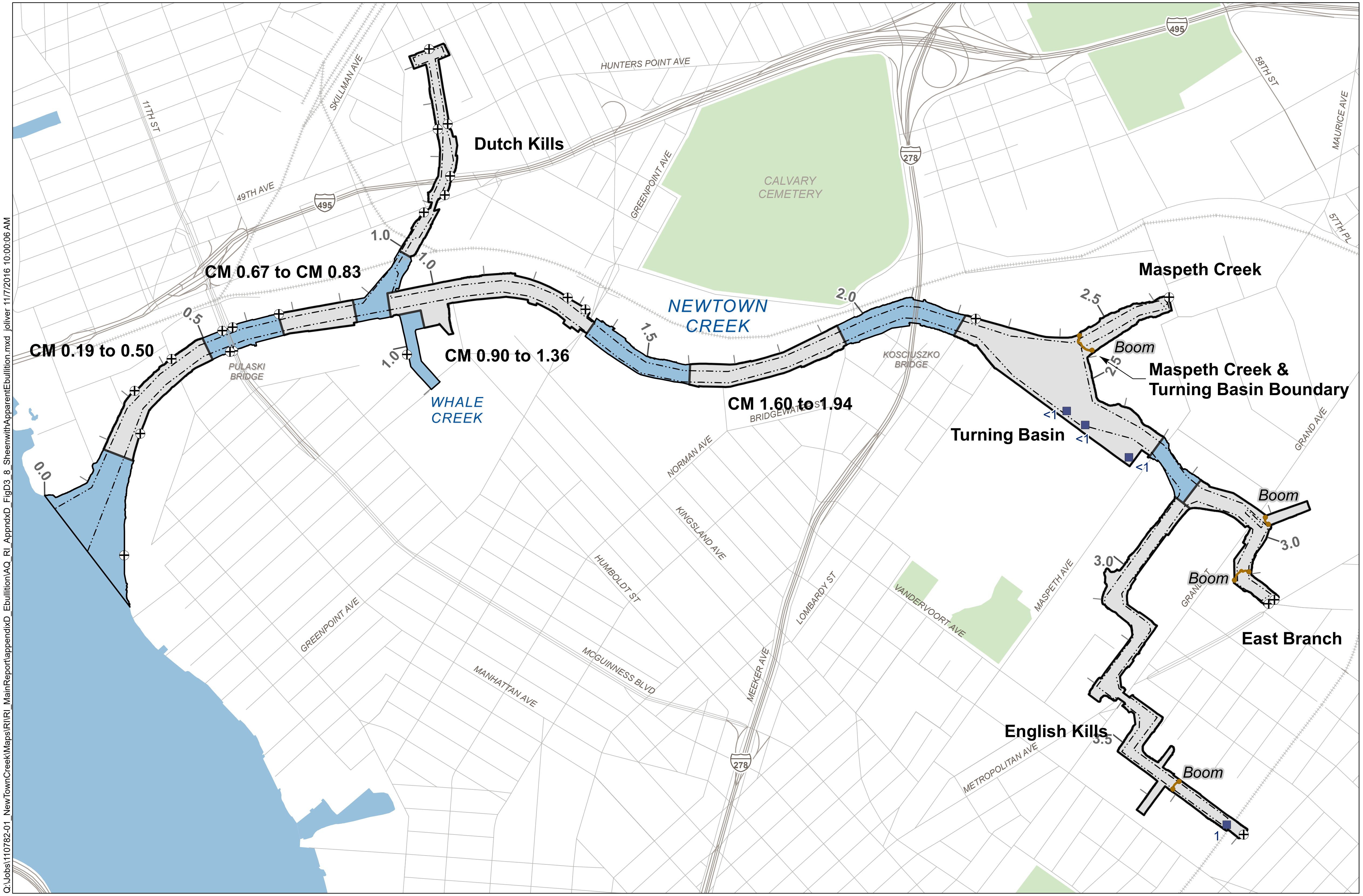
Dutch Kills Survey Area
Silvery, brittle, small spots



English Kills Survey Area
Rainbow, non-brittle, small spots

CM 1.6 to 1.94 Survey Area
Silvery, non-brittle, contiguous

Turning Basin Survey Area
Rainbow, brittle, spotty



Newtown Creek Study Area
Waterbody
Open Space
Navigation Channel
Boom
Survey Area
Combined Sewer Outfall
Sheen Blossom Observations

Notes:
1. Base data acquired from New York City Department of Information Technology and Telecommunications.
2. The spatial extent of sheen observations is shown as polygons; sheen observations smaller than 3,000 square feet in size are shown as filled square points instead of actual areas.
3. Numbers indicate the rate of blossoms observed per minute.
4. Creek mile hatches are shown every tenth mile and labeled every half mile.
5. Table D2-2 summarizes the start and end times for the survey.
6. Boom forms boundary between Maspeth Creek and Turning Basin survey areas.
7. Nine portions of the Study Area were surveyed during the gas ebullition field survey.

0 500 1,000 1,500 Feet

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Figure D3-8
Summary of 2015 Sheen Blossom Observations for All Surveys
Gas Ebullition Evaluation
Newtown Creek RI/FS

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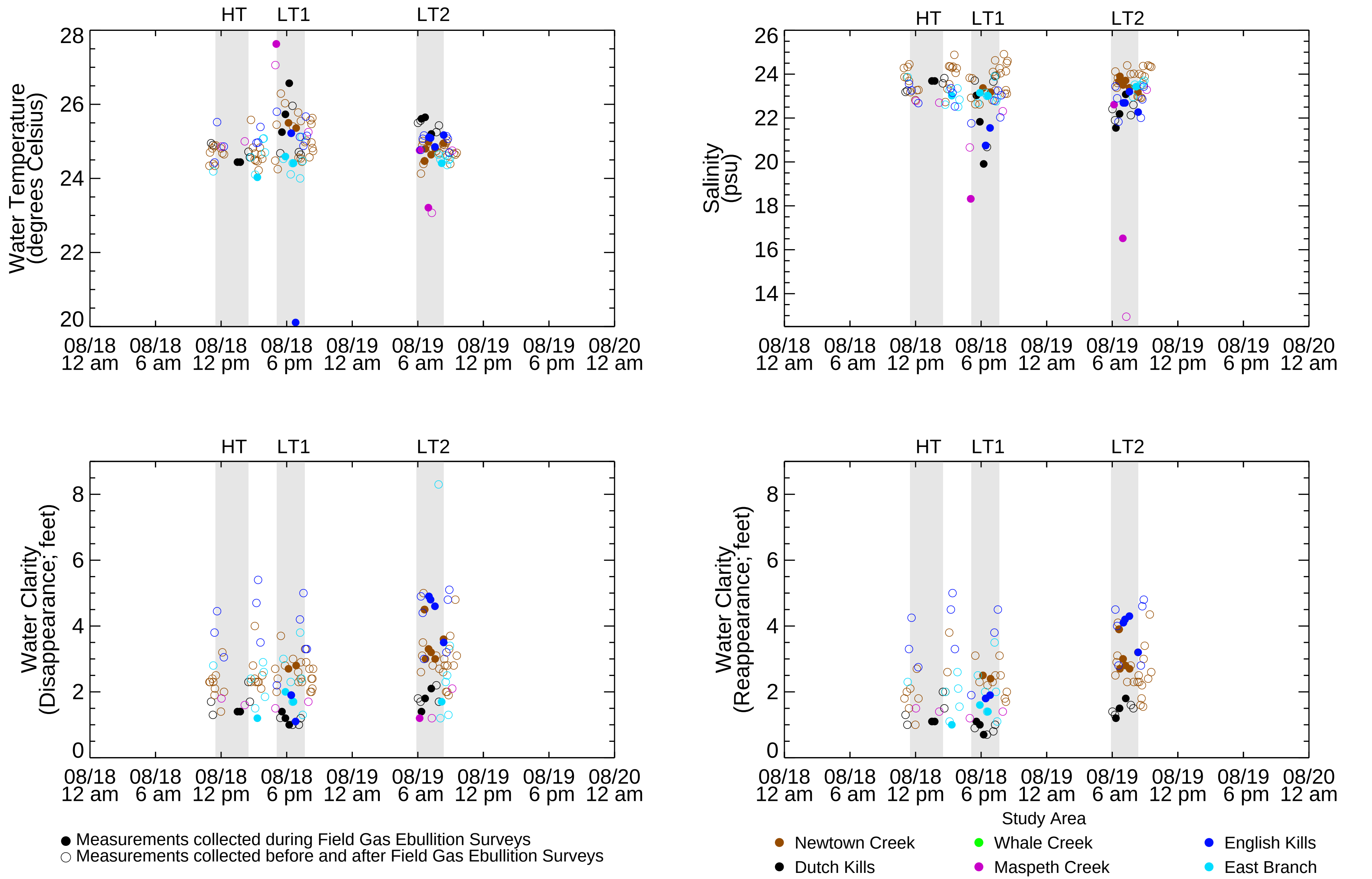

Figure D3-9

Surface Water Quality Measurements - 2015
Gas Ebullition Evaluation
Newtown Creek RI/FS

Notes: Shaded areas indicate time of surveys.
One water temperature measurement was treated as an extreme outlier due to a measurement error and removed from the analysis.
HT: High Tide Survey No. 1; LT1: Low Tide Survey No. 1; LT2: Low Tide Survey No. 2

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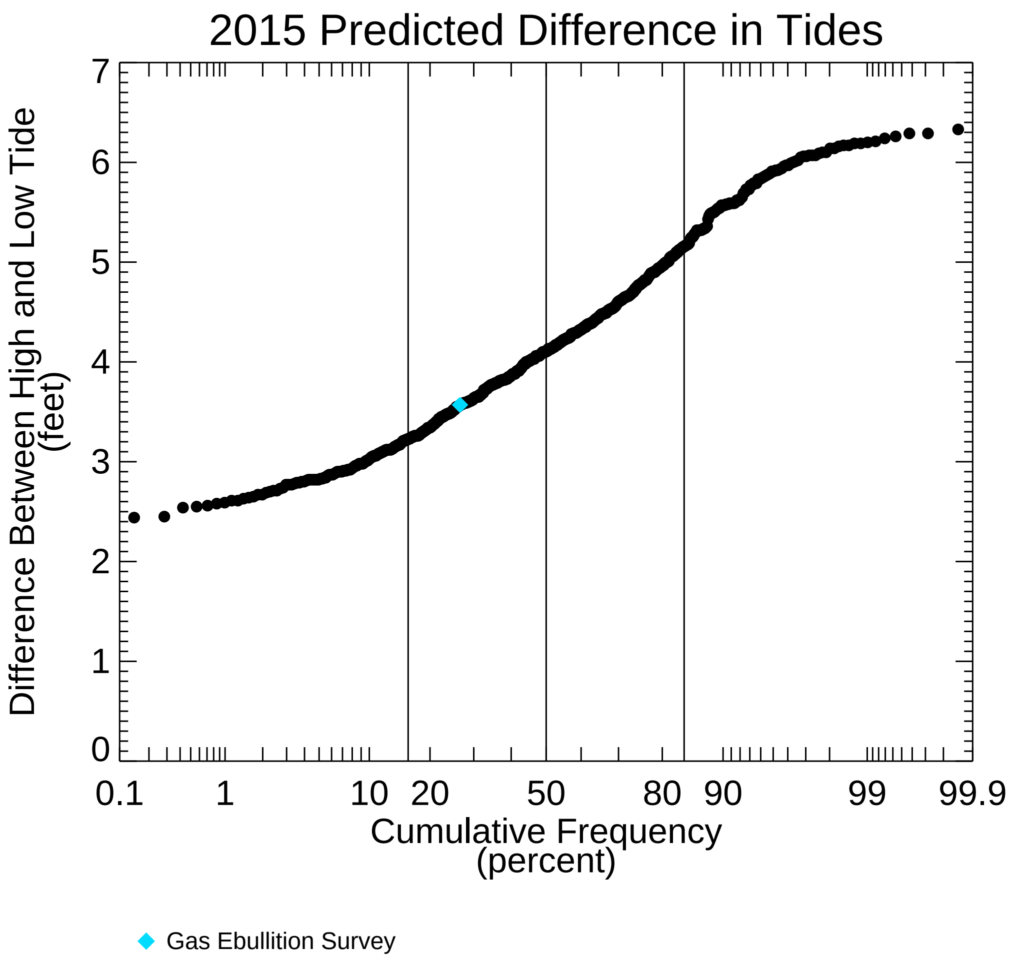

Figure D3-10

Differences Between High and Low Tides - 2015
Gas Ebullition Evaluation
Newtown Creek RI/FS

Note: Estimated tidal elevation data, referenced to the mean lower low water (MLLW) tidal datum, obtained from National Oceanic and Atmospheric Administration (NOAA) for Hunters Point, Newtown Creek, NY.

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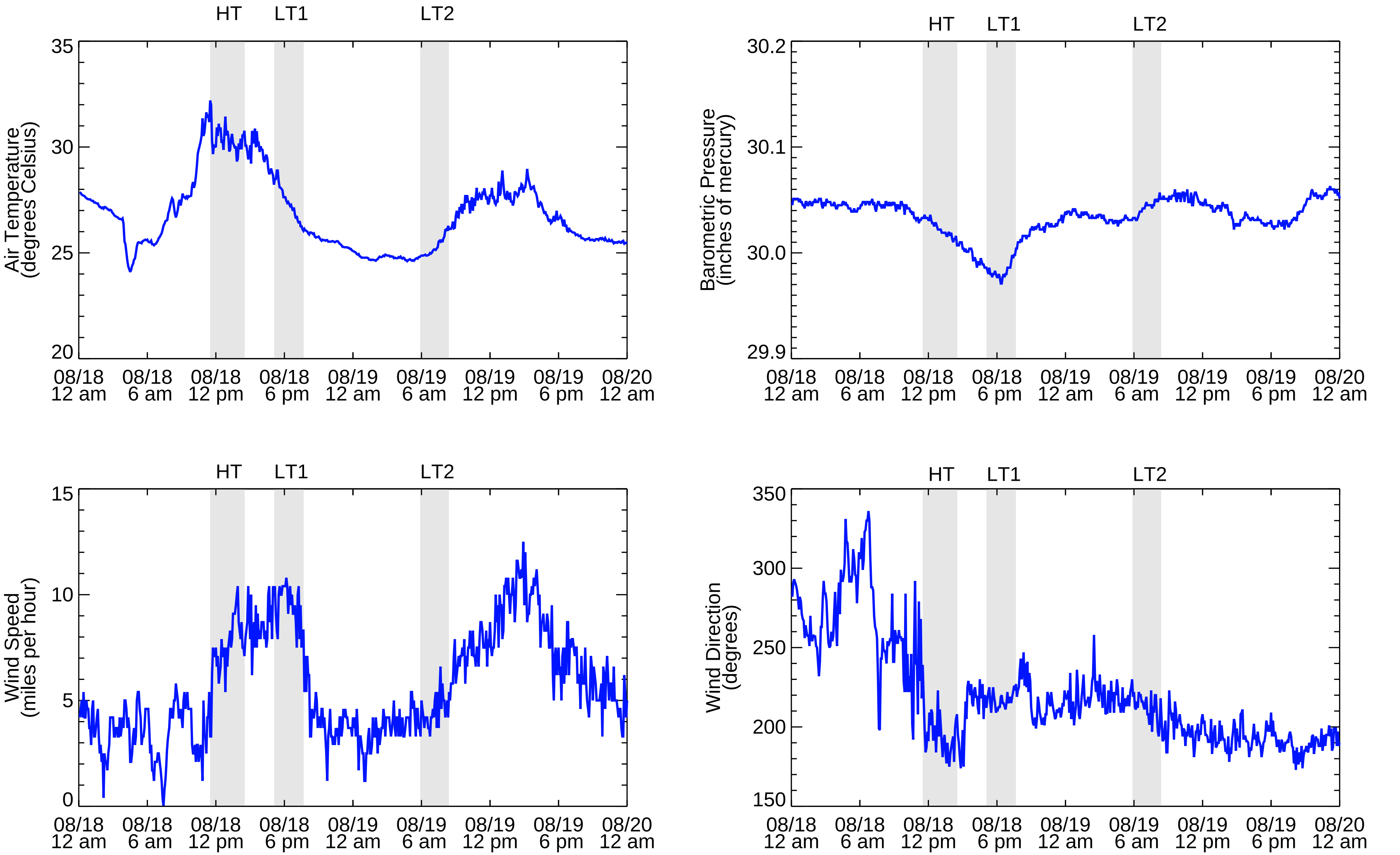

Figure D3-11

Weather Conditions - 2015
Gas Ebullition Evaluation
Newtown Creek RI/FS

Notes: Data obtained from Greenpoint Energy Center weather station.
Barometric pressure: 1 bar = 29.61 inches of mercury (at 16 degrees Celsius). Shaded areas indicate time of surveys.
HT: High Tide Survey No. 1; LT1: Low Tide Survey No. 1; LT2: Low Tide Survey No. 2

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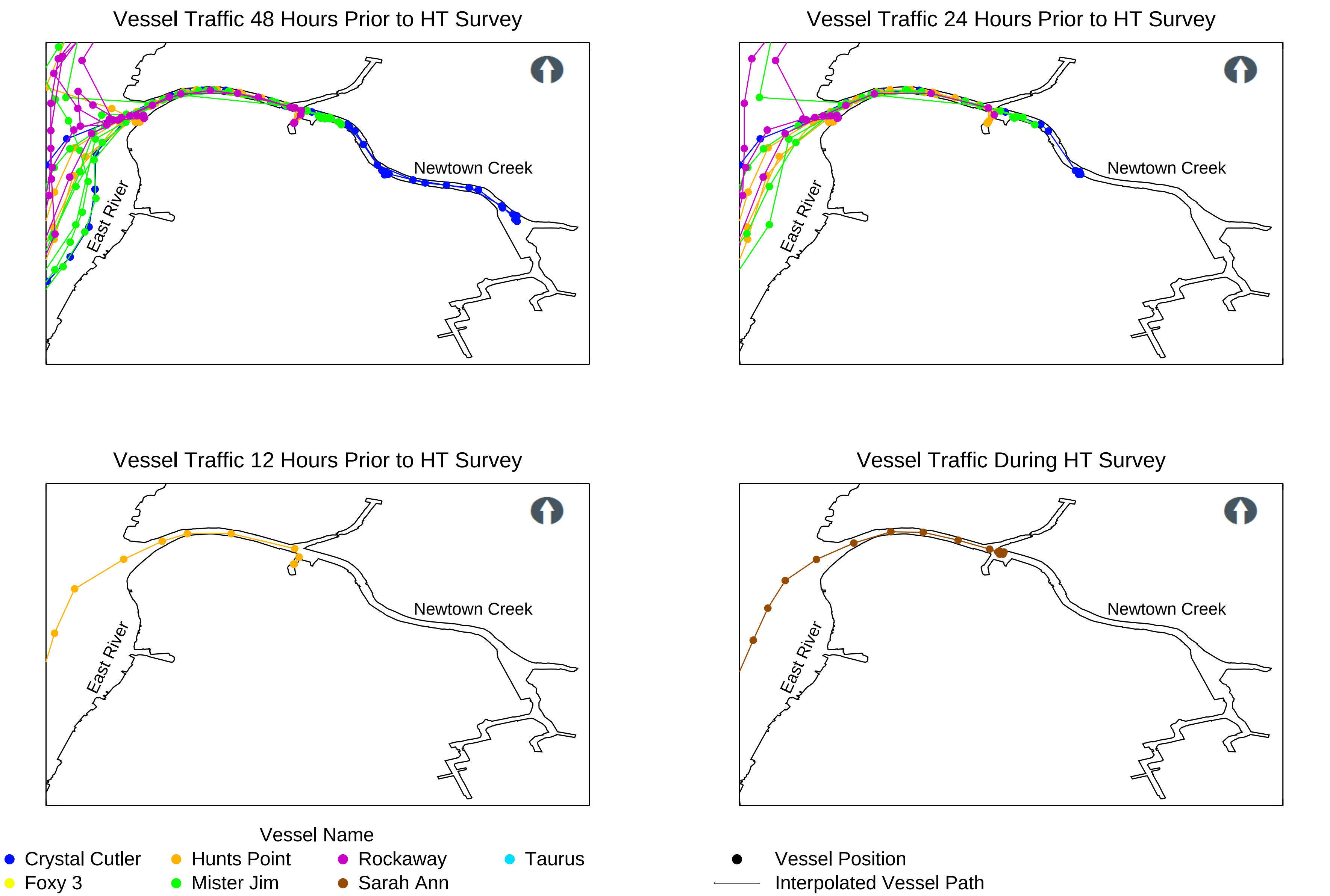

Figure D3-12a

Vessel Traffic Prior to and During the High Tide Survey - 2015
Gas Ebullition Evaluation
Newtown Creek RI/FS

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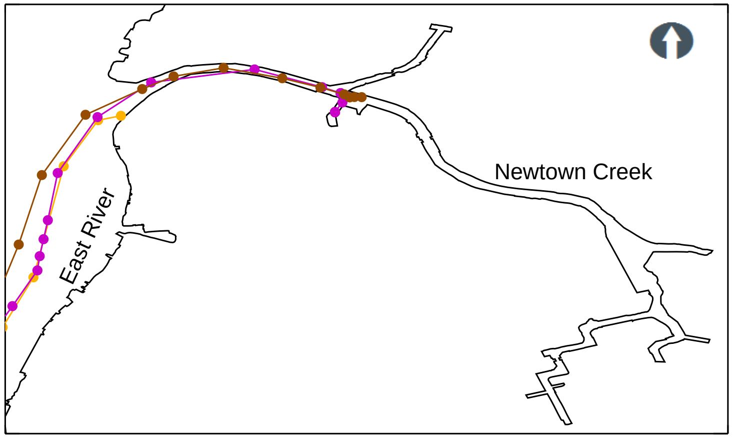
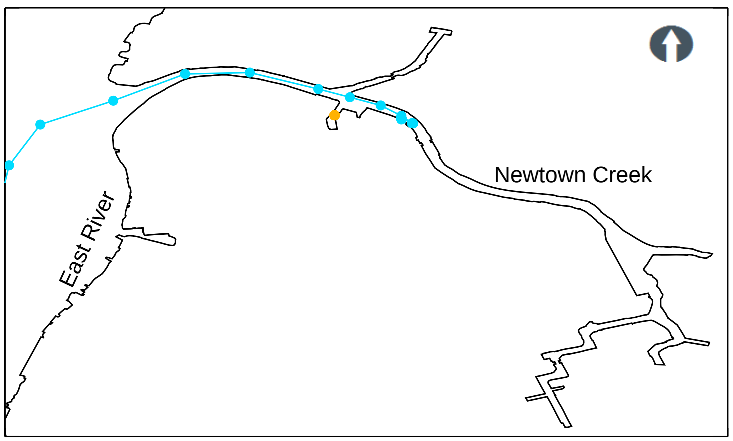
Notes: Only data from registered vessels available from Marine Traffic website.
HT: High Tide Survey No. 1; LT1: Low Tide Survey No. 1; LT2: Low Tide Survey No. 2

Vessel Traffic Between HT and LT1 Surveys

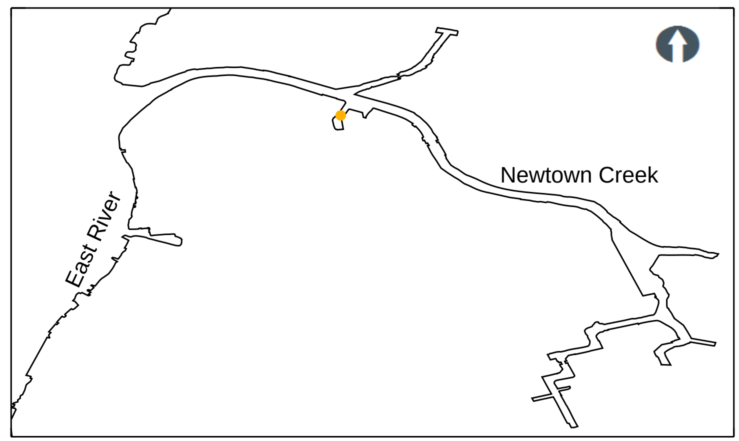


Vessel Traffic During LT1 Survey

Vessel Traffic Between LT1 and LT2 Surveys



Vessel Traffic During LT2 Survey



Vessel Name

● Crystal Cutler ● Hunts Point ● Rockaway ● Taurus
● Foxy 3 ● Mister Jim ● Sarah Ann

● Vessel Position
— Interpolated Vessel Path

Figure D3-12b

Vessel Traffic Prior to, During, and Between the Low Tide Surveys - 2015
Gas Ebullition Evaluation
Newtown Creek RI/FS

ANCHOR QEA

Notes: Only data from registered vessels available from Marine Traffic website.
HT: High Tide Survey No. 1; LT1: Low Tide Survey No. 1; LT2: Low Tide Survey No. 2

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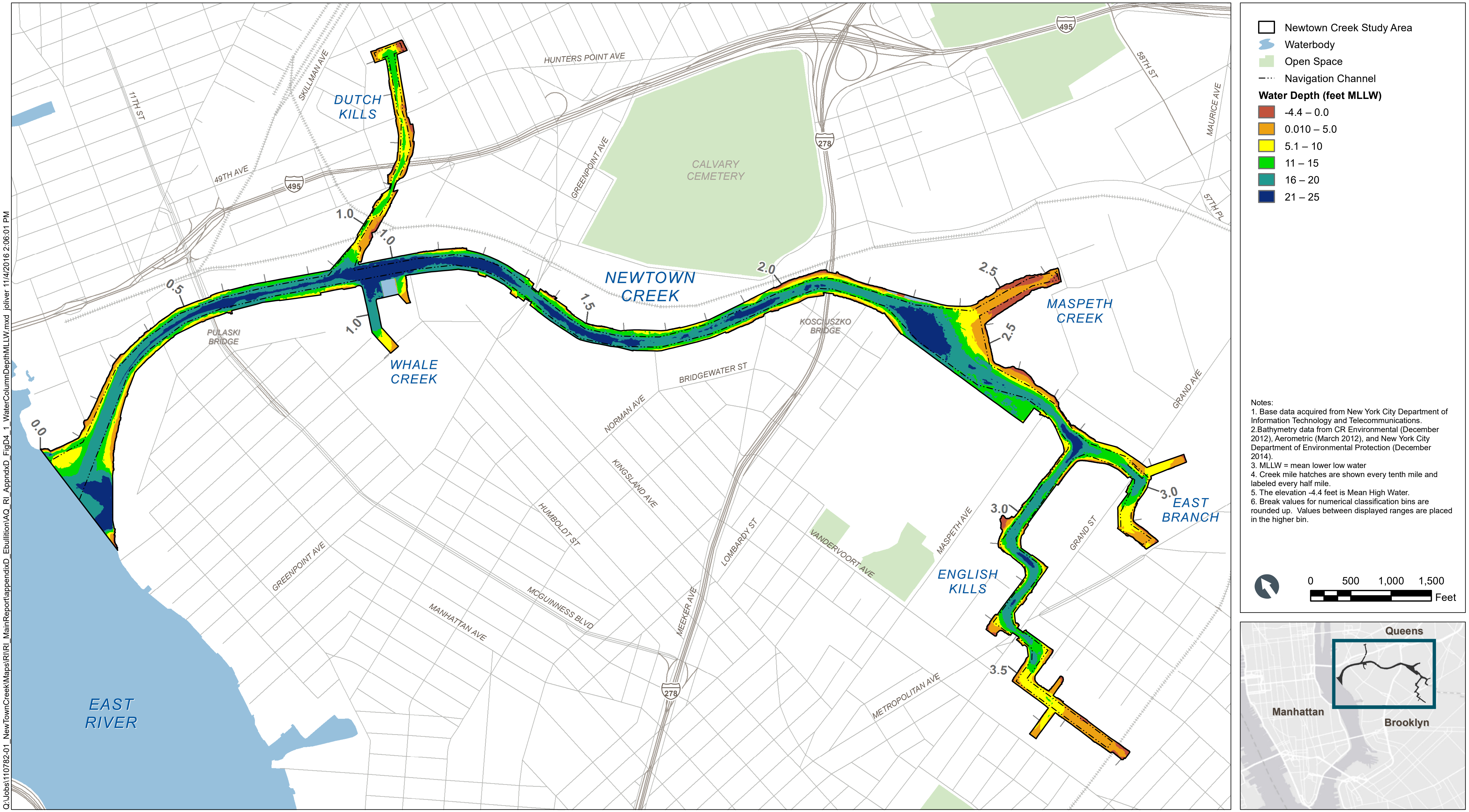

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ANCHOR QEA

Figure D4-1
Water Column Depth
Gas Ebullition Evaluation
Newtown Creek RI/FS

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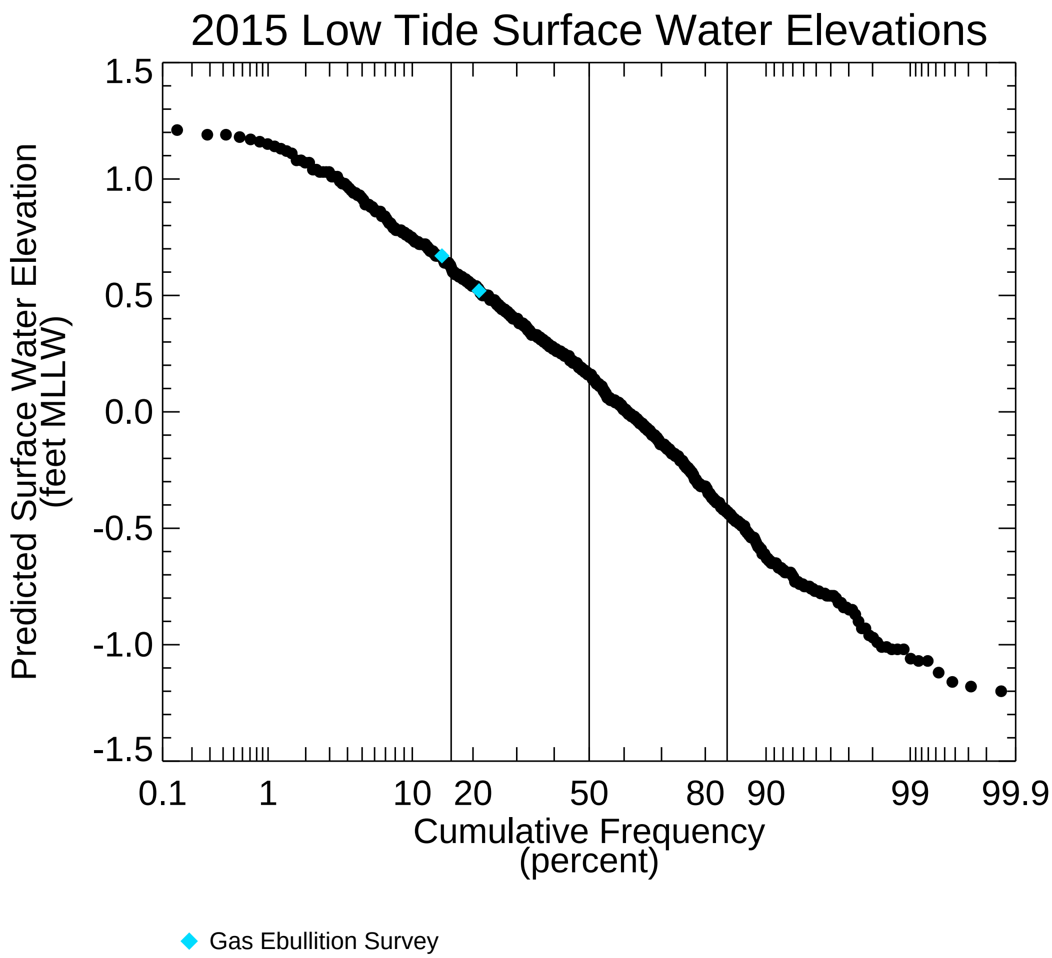


Figure D4-2
Low Tide Surface Water Elevations - 2015
Gas Ebullition Evaluation
Newtown Creek RI/FS

Note: Estimated tidal elevation data, referenced to the mean lower low water (MLLW) tidal datum, obtained from National Oceanic and Atmospheric Administration (NOAA) for Hunters Point, Newtown Creek, NY.

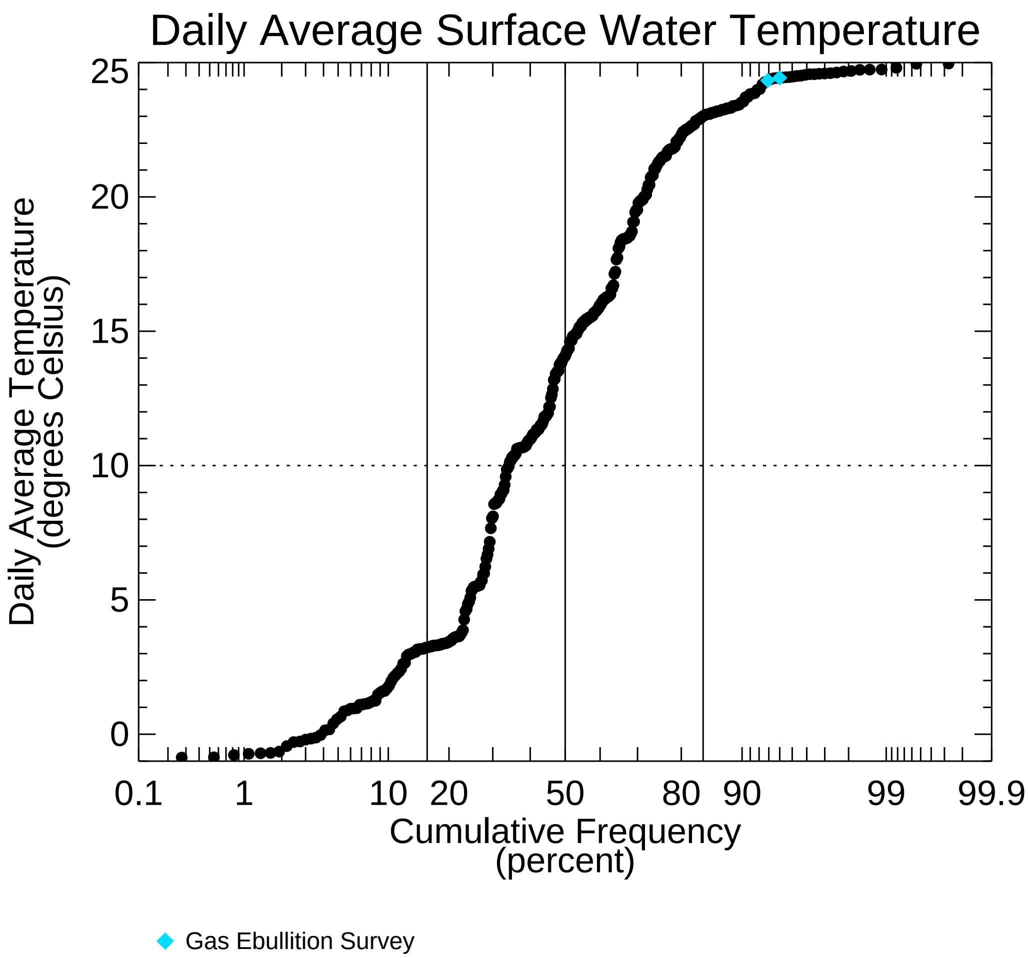


Figure D4-3

Daily Average Surface Water Temperatures at The Battery - 2015

Gas Ebullition Evaluation

Newtown Creek RI/FS

Note: Surface water temperatures obtained from National Oceanic and Atmospheric Administration (NOAA) for The Battery, NY.

ANCHOR QEA

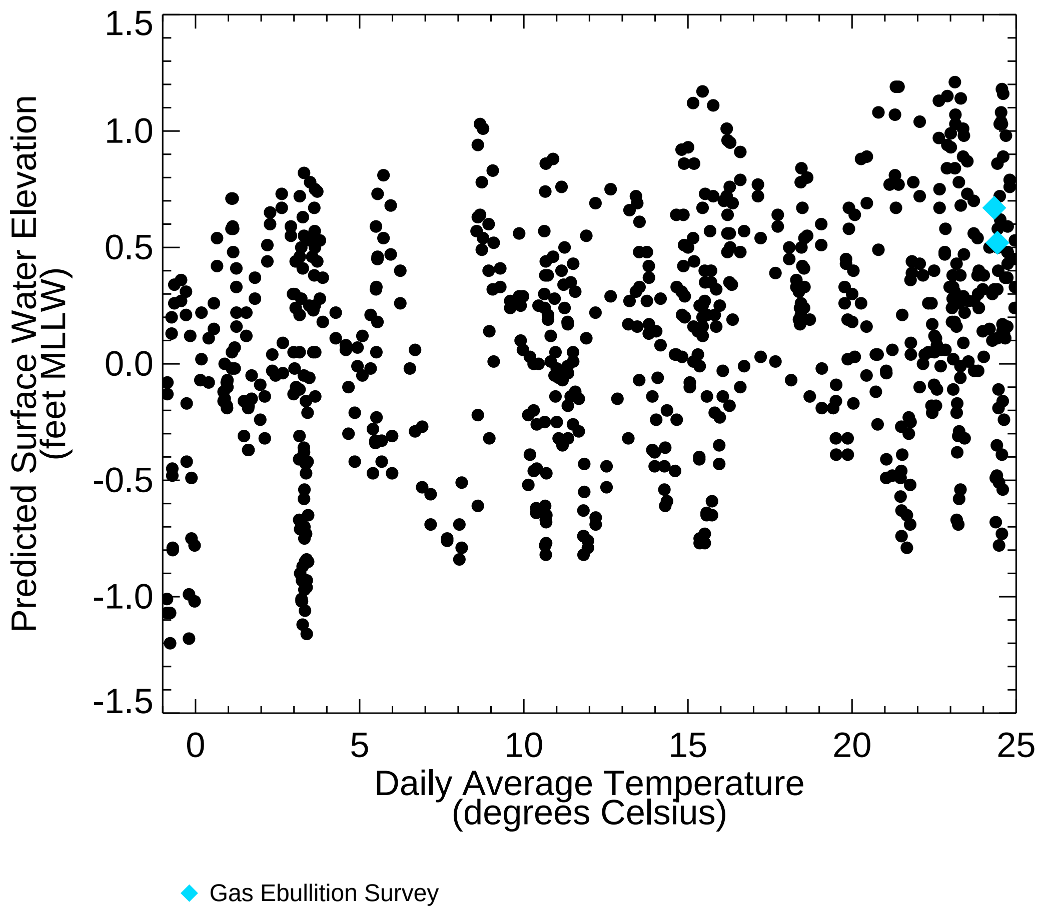


Figure D4-4

Low Tide Surface Water Elevations Compared to
Daily Average Surface Water Temperatures - 2015
Gas Ebullition Evaluation
Newtown Creek RI/FS

ANCHOR QEA

Notes: Estimated tidal elevation data, referenced to the mean lower low water (MLLW) tidal datum, obtained from National Oceanic and Atmospheric Administration (NOAA) for Hunters Point, Newtown Creek, NY. Surface water temperatures obtained from NOAA for The Battery, NY.

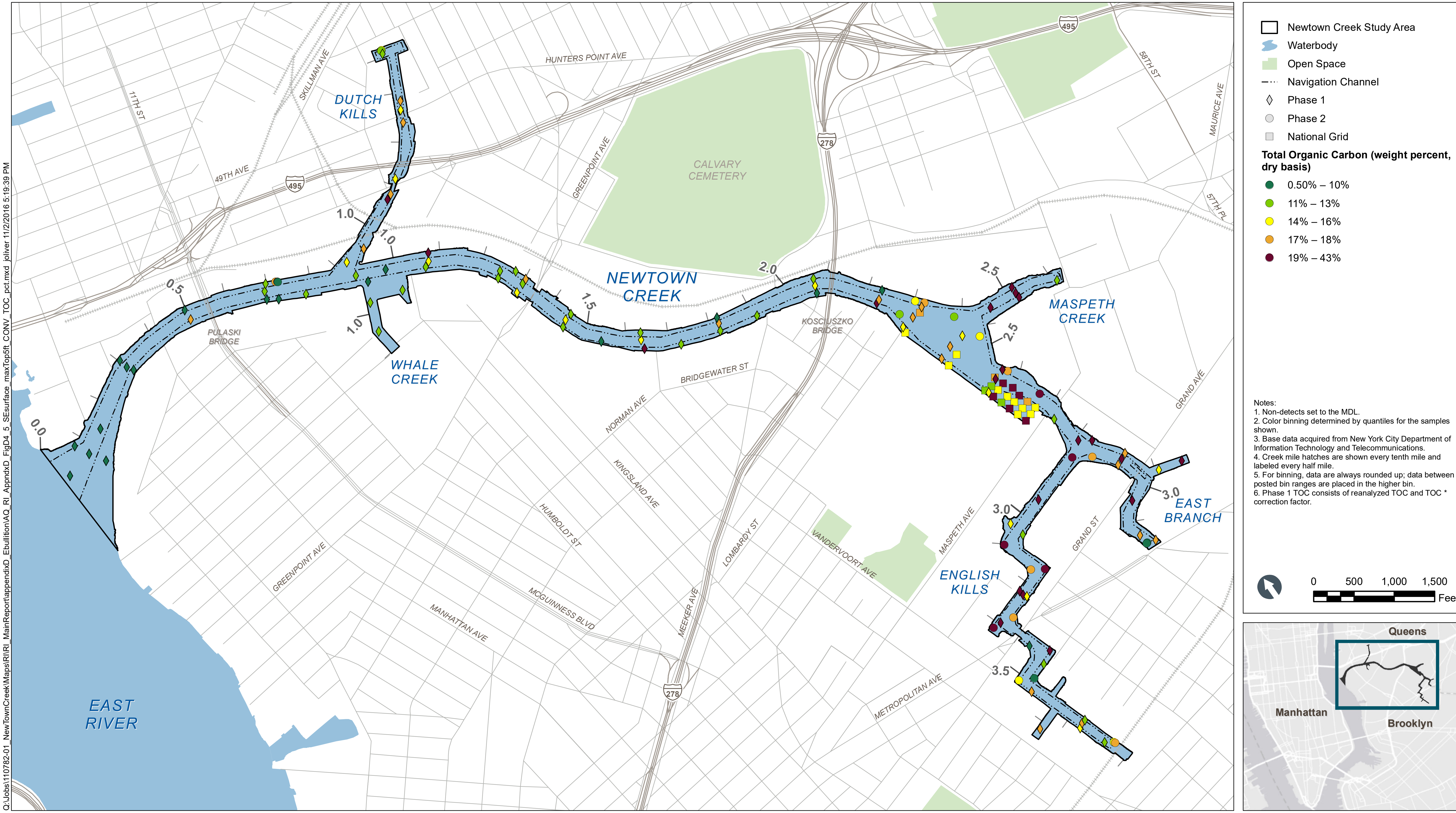


Figure D4-5
Maximum TOC Concentrations in the Top 5 Feet of Sediment
Gas Ebullition Evaluation
Newtown Creek RI/FS

DRAFT

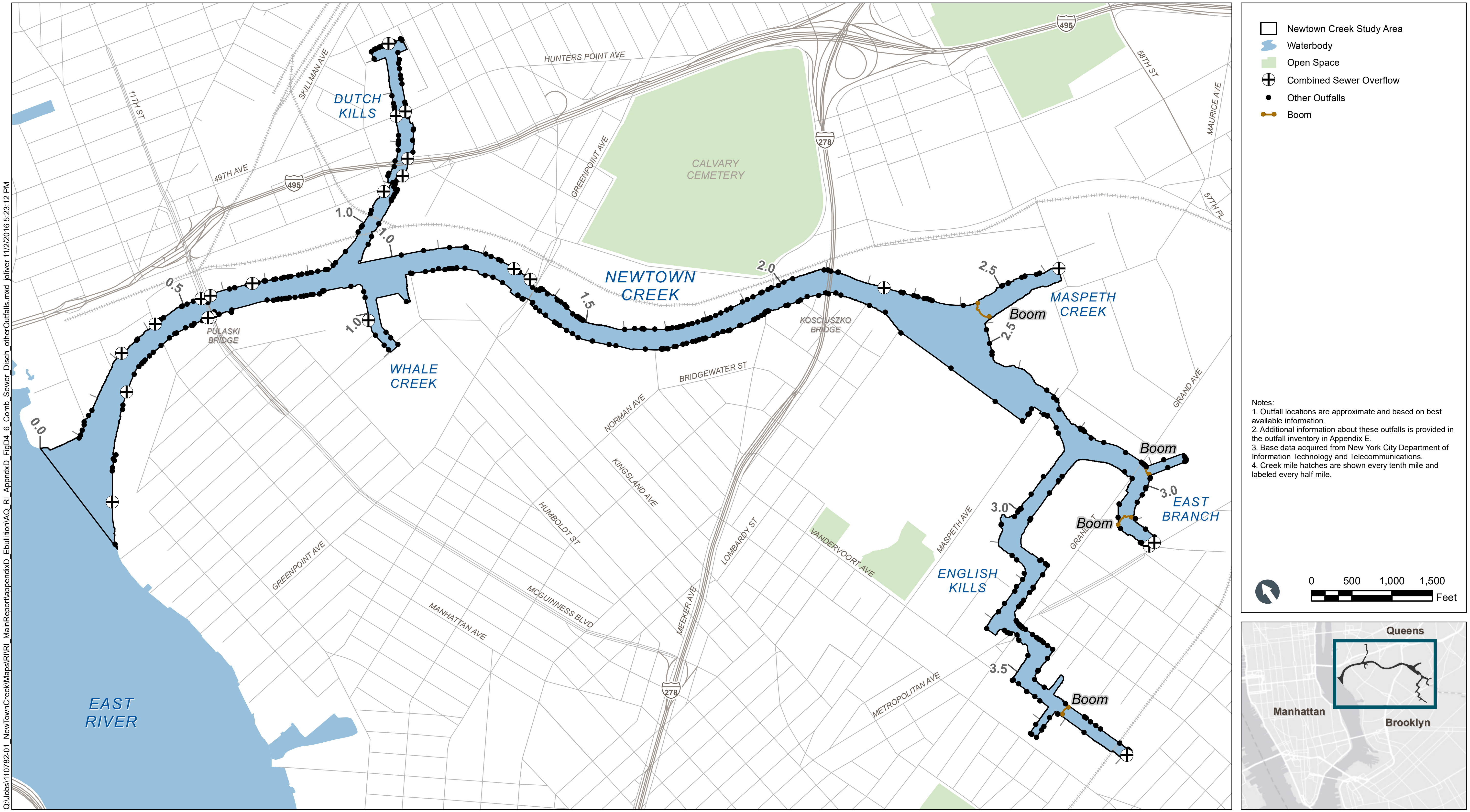
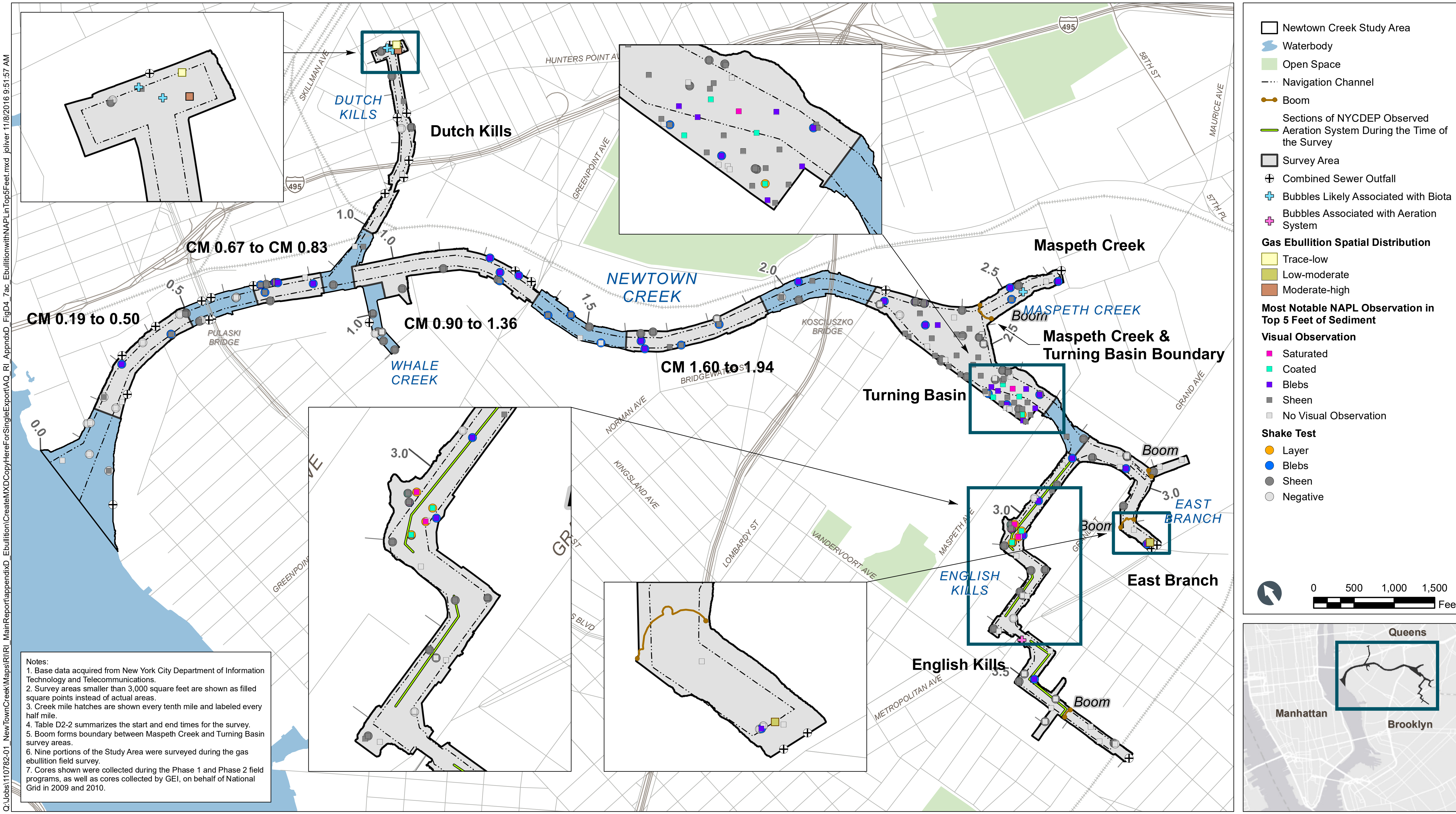


Figure D4-6
Combined Sewer Overflow and Other Outfalls that Discharge to the Study Area
Gas Ebullition Evaluation
Newtown Creek RI/FS

DRAFT



Notes:
1. Base data acquired from New York City Department of Information Technology and Telecommunications.
2. Survey areas smaller than 3,000 square feet are shown as filled square points instead of actual areas.
3. Creek mile hatches are shown every tenth mile and labeled every half mile.
4. Table D2-2 summarizes the start and end times for the survey.
5. Boom forms boundary between Maspeth Creek and Turning Basin survey areas.
6. Nine portions of the Study Area were surveyed during the gas ebullition field survey.
7. Cores shown were collected during the Phase 1 and Phase 2 field programs, as well as cores collected by GEI, on behalf of National Grid in 2009 and 2010.

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Figure D4-7a
Apparent Gas Ebullition Observations and NAPL Observations in the Top 5 Feet of Sediment – 2015 High Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS

ANCHOR QEA

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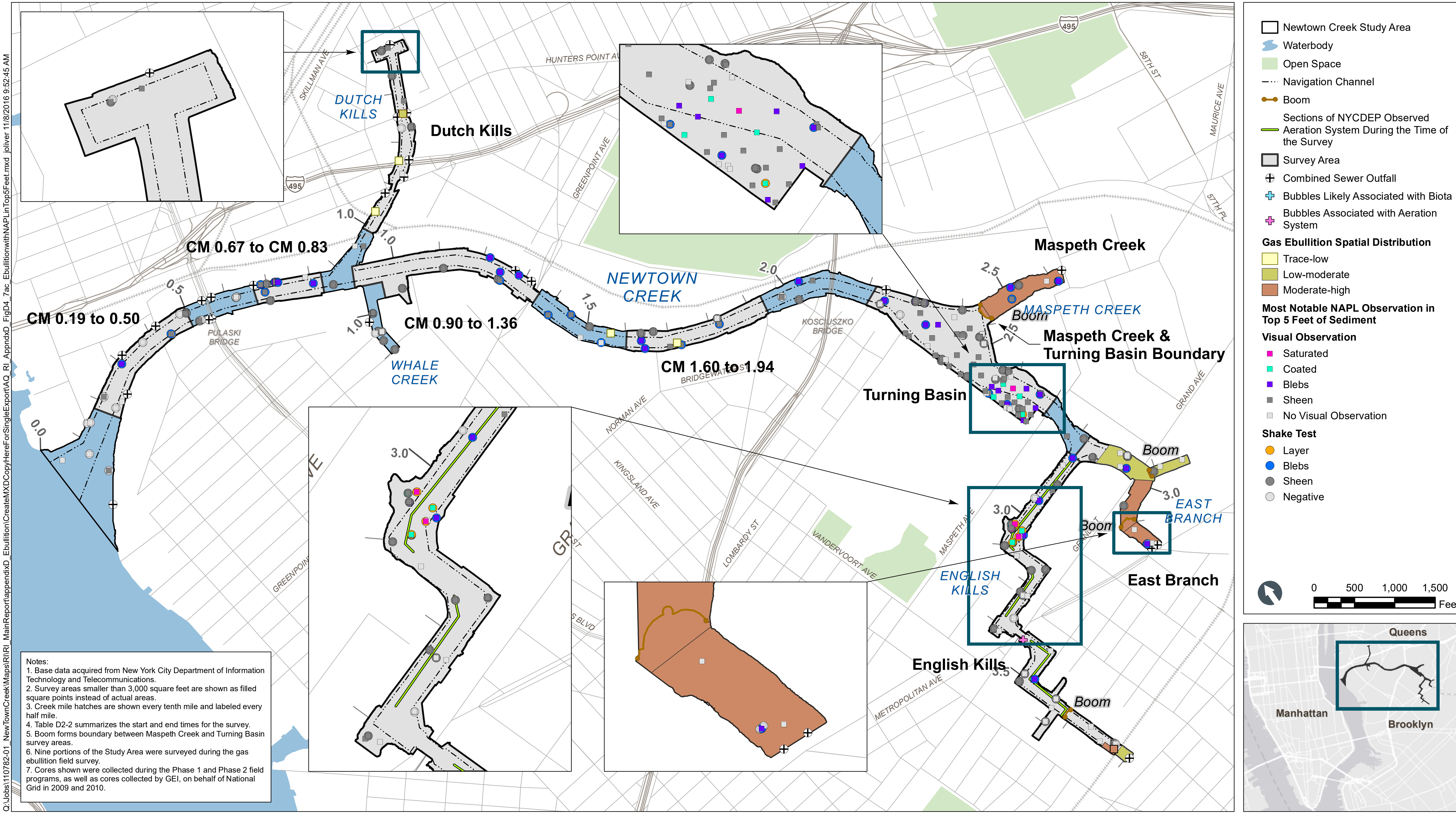

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Figure D4-7b
Apparent Gas Ebullition Observations and NAPL Observations in the Top 5 Feet of Sediment – 2015 Low Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS

ANCHOR QEA

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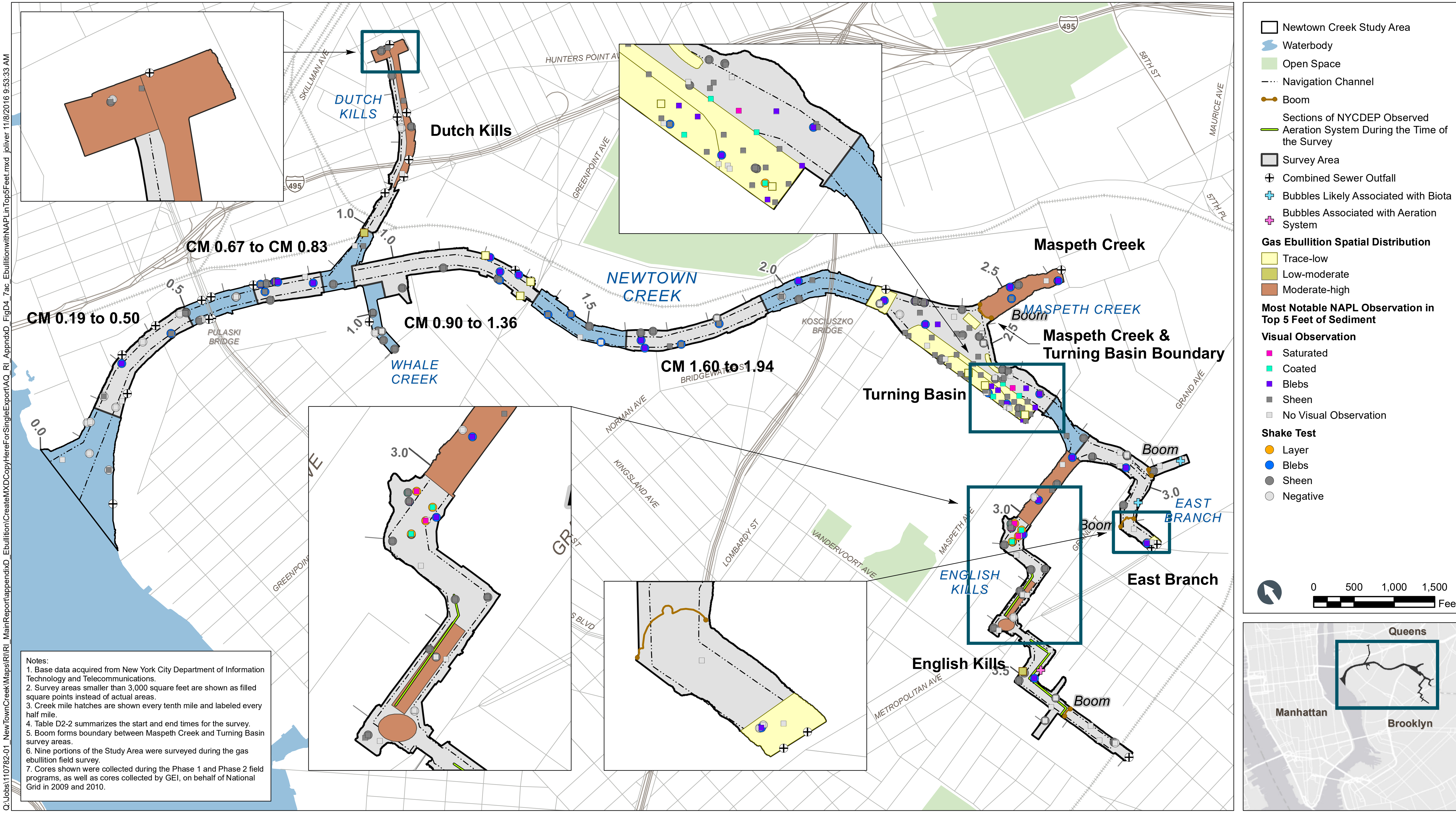

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Figure D4-7c
Apparent Gas Ebullition Observations and NAPL Observations in the Top 5 Feet of Sediment – 2015 Low Tide Survey No. 2
Gas Ebullition Evaluation
Newtown Creek RI/FS

ANCHOR QEA

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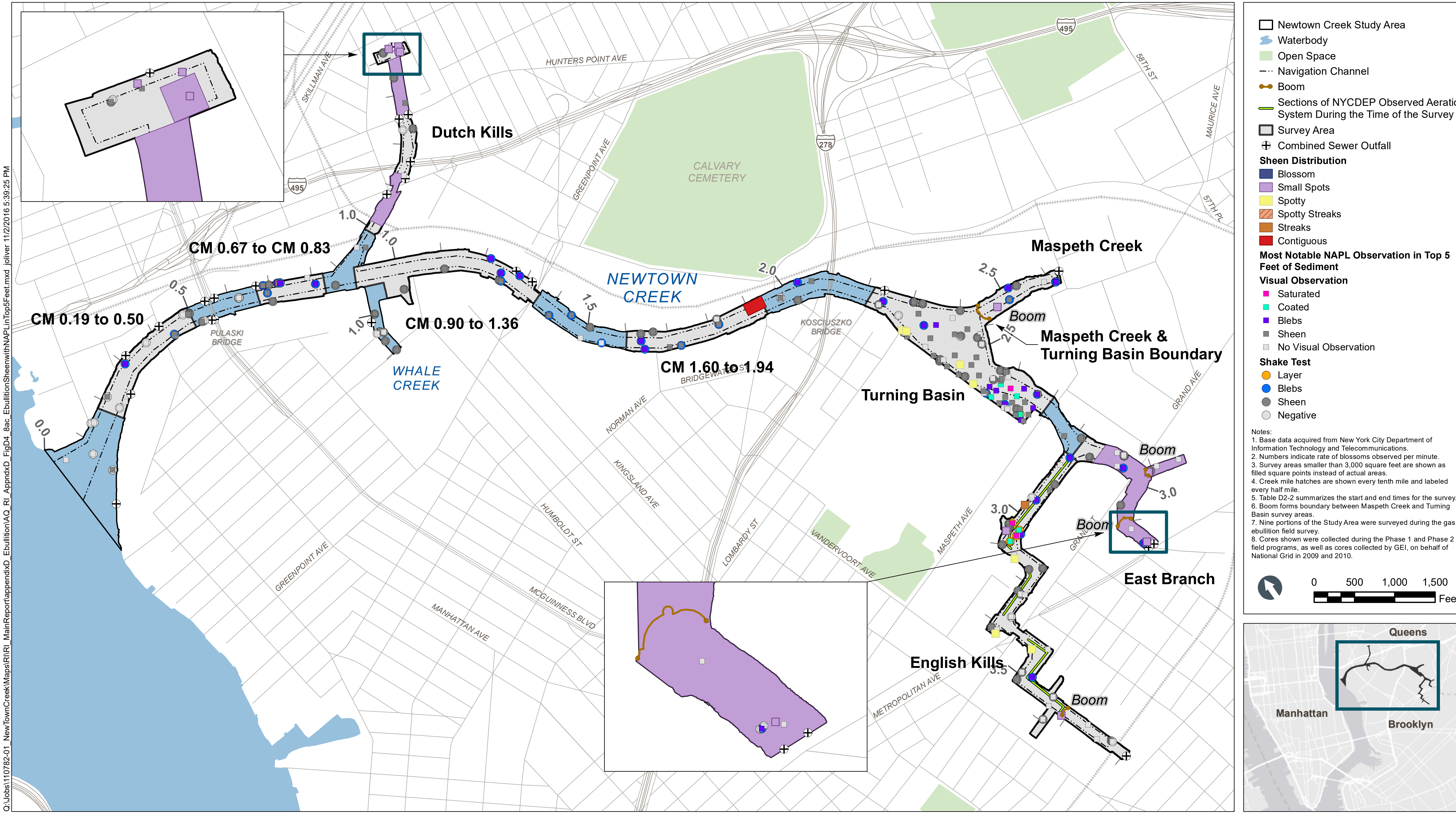

Figure D4-8a
Surface Water Sheen Observations and NAPL Observations in the Top 5 Feet of Sediment – 2015 High Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS

DRAFT

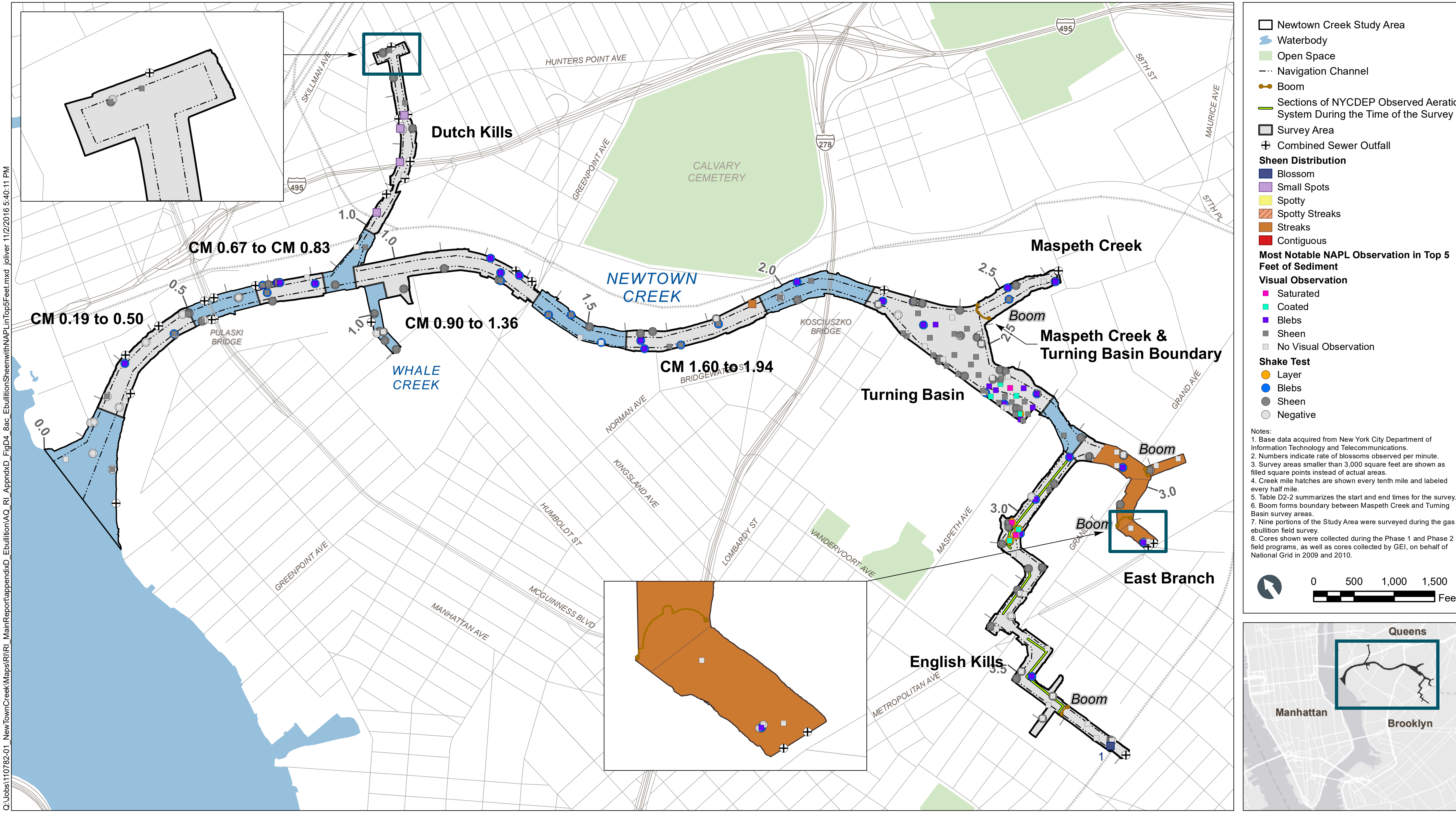

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Figure D4-8b
Surface Water Sheen Observations and NAPL Observations in the Top 5 Feet of Sediment – 2015 Low Tide Survey No. 1
Gas Ebullition Evaluation
Newtown Creek RI/FS

ANCHOR QEA

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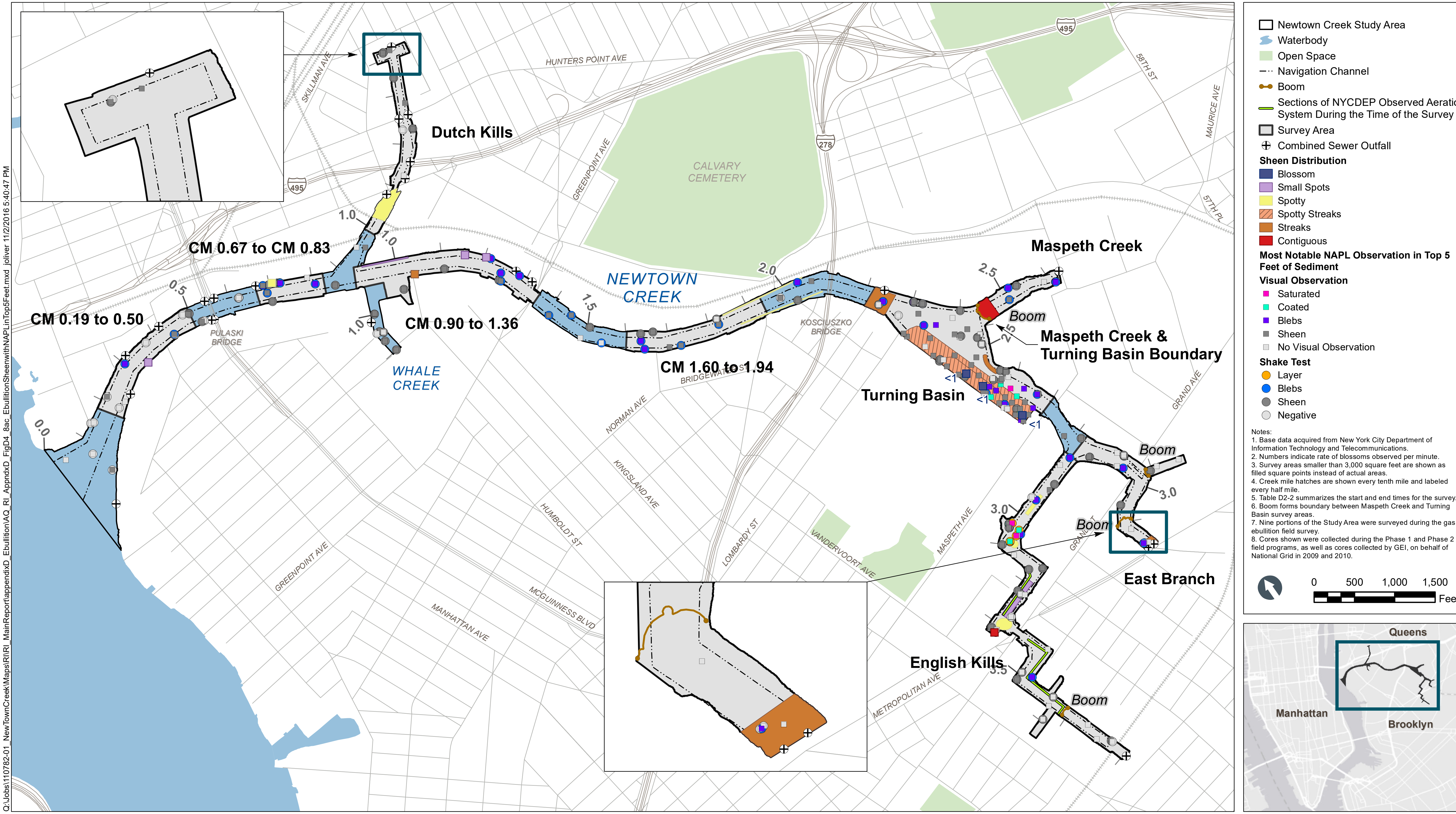

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ANCHOR QEA

Figure D4-8c
Surface Water Sheen Observations and NAPL Observations in the Top 5 Feet of Sediment – 2015 Low Tide Survey No. 2
Gas Ebullition Evaluation
Newtown Creek RI/FS

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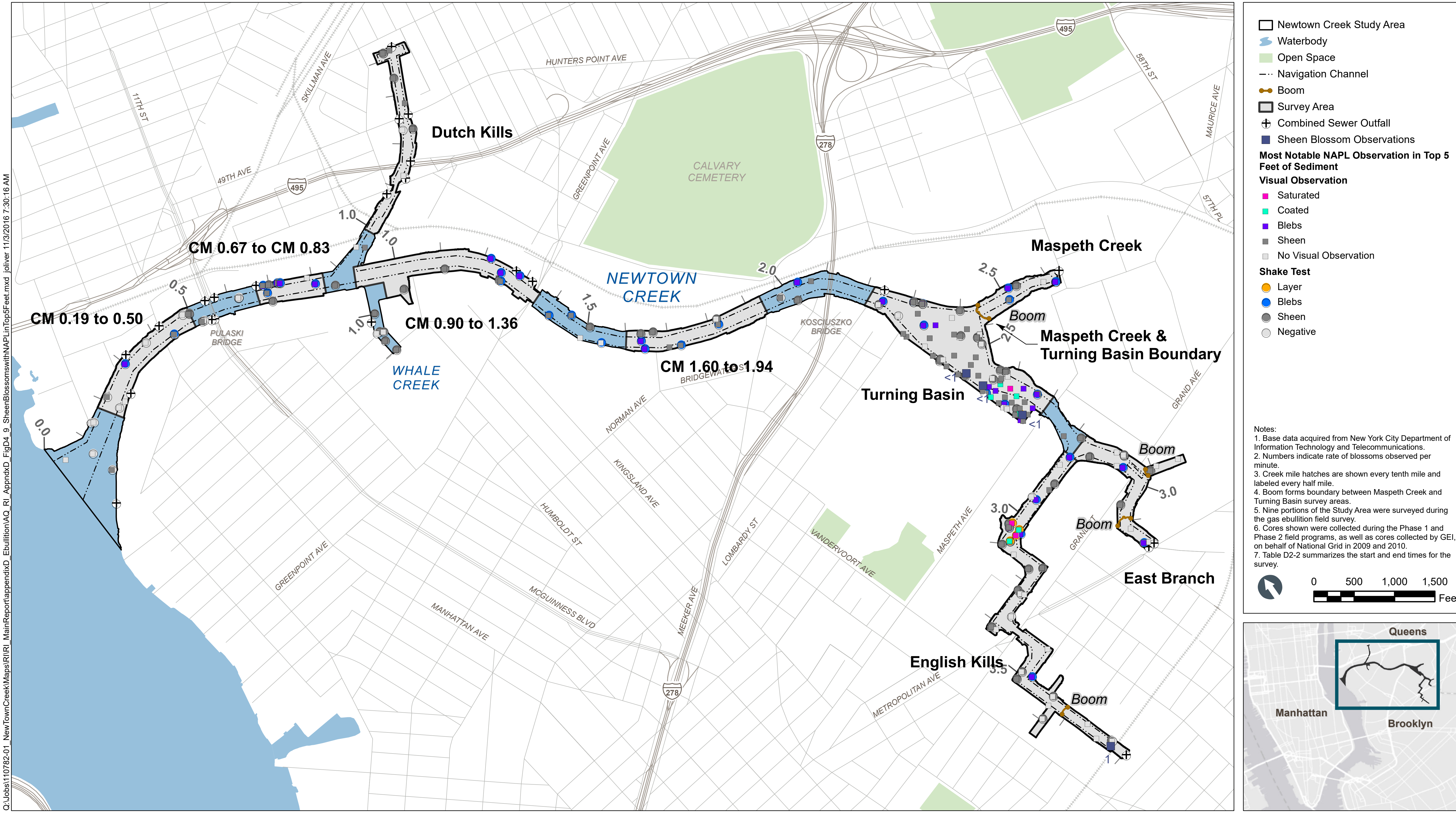

Figure D4-9
Summary of 2015 Sheen Blossom Observations for All Surveys
and NAPL Observations in the Top 5 Feet of Sediment
Gas Ebullition Evaluation
Newtown Creek RI/FS

ANCHOR QEA

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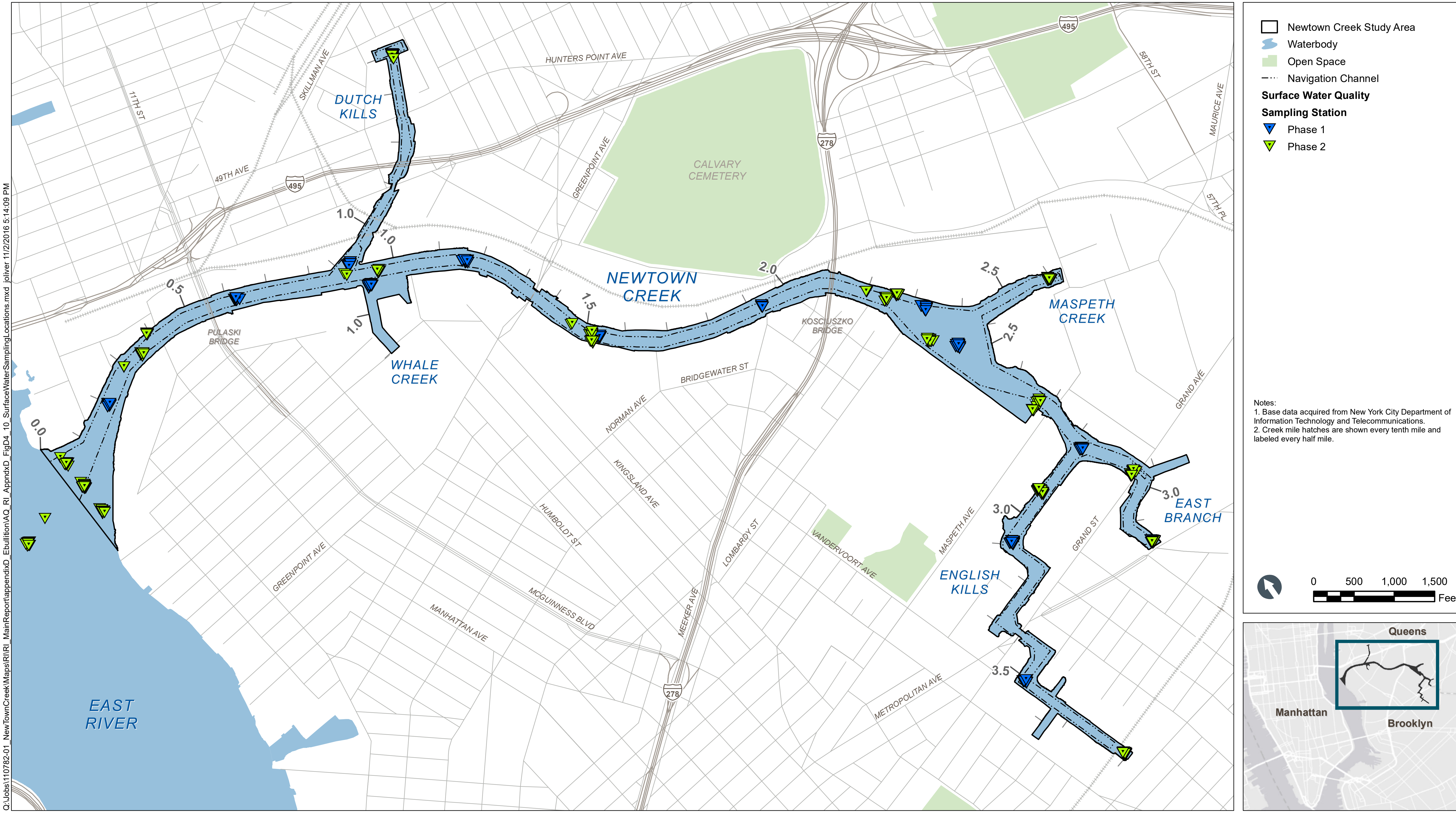

ANCHOR QEA

Figure D4-10
Surface Water Sampling Stations
Gas Ebulition Evaluation
Newtown Creek RI/FS

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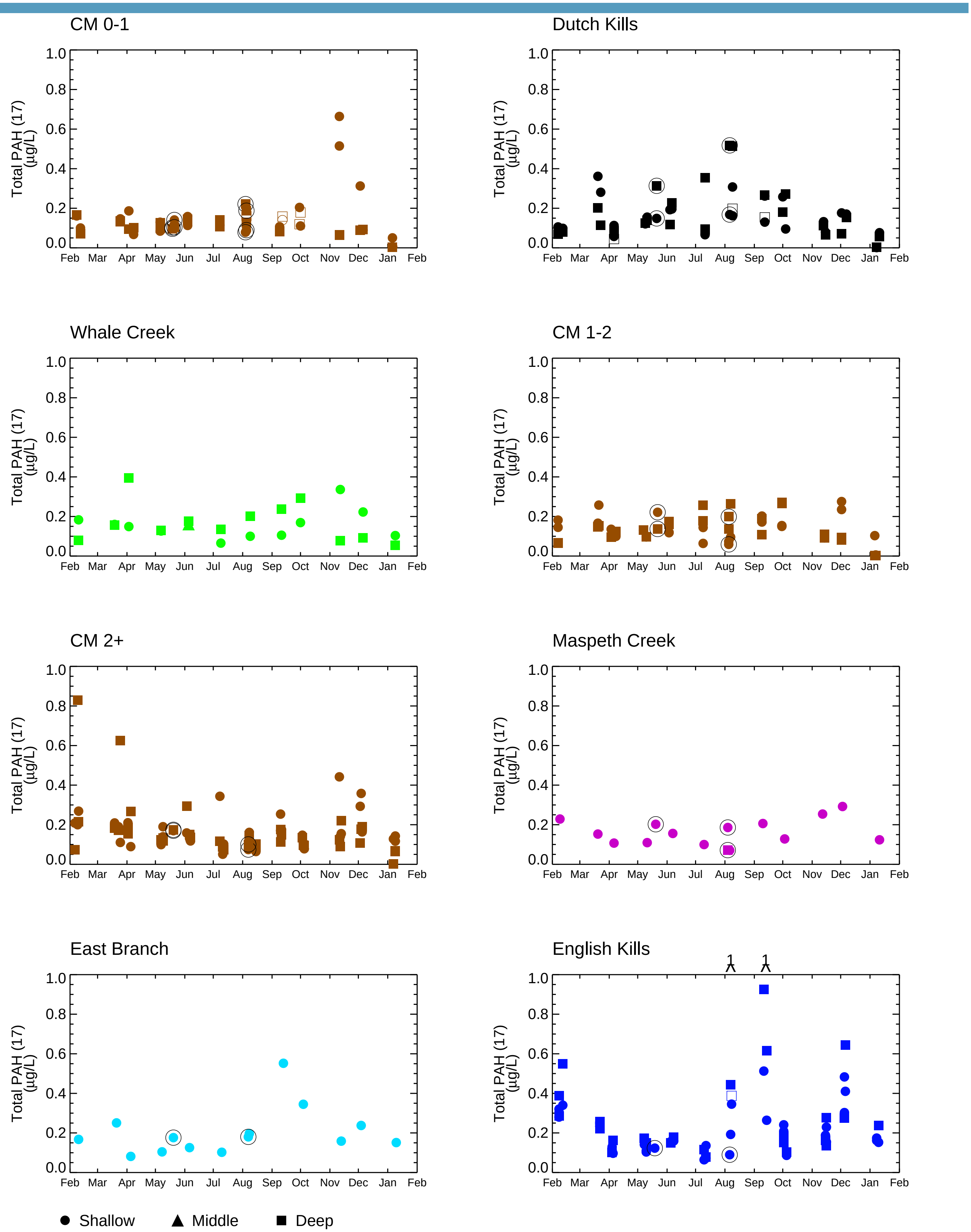

Figure D4-11

Total PAH (17) in Surface Water During Dry Weather Sampling Events - Temporal Plots
Gas Ebullition Evaluation
Newtown Creek RI/FS

ANCHOR QEA

Notes: Non-detects set to the MDL and plotted with open symbol. Caret symbols above or below panel indicate the number of values outside y-axis range. Totals reported using Kaplan-Meier, if applicable. Samples collected during Phase 2 identified with a halo around symbol. Phase 1 samples collected in February 2012 to January 2013. Phase 2 samples collected in May and August 2014. Shallow samples collected within 3 feet of water surface, middle samples collected from midpoint of water depth, and deep samples collected within three 3 of sediment surface.

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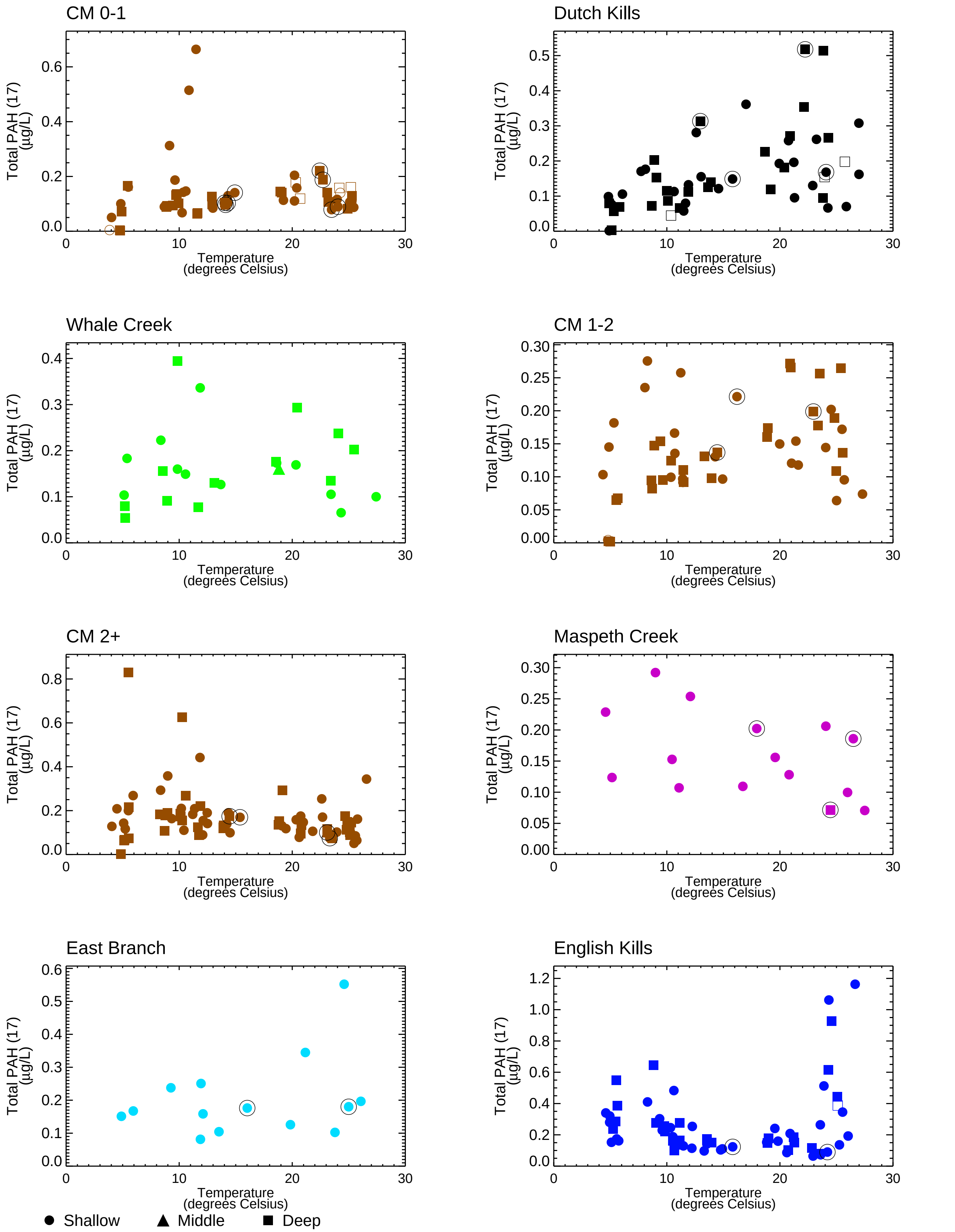

Figure D4-12

Total PAH (17) in Surface Water During Dry Weather Sampling Events
versus Surface Water Temperature
Gas Ebullition Evaluation
Newtown Creek RI/FS

ANCHOR QEA

Notes: Non-detects set to the MDL and plotted with open symbol. Totals reported using Kaplan-Meier, if applicable. Samples collected during Phase 2 identified with a halo around symbol. Shallow samples collected within 3 feet of water surface, middle samples from midpoint of water depth, and deep samples collected within 3 feet of sediment surface.

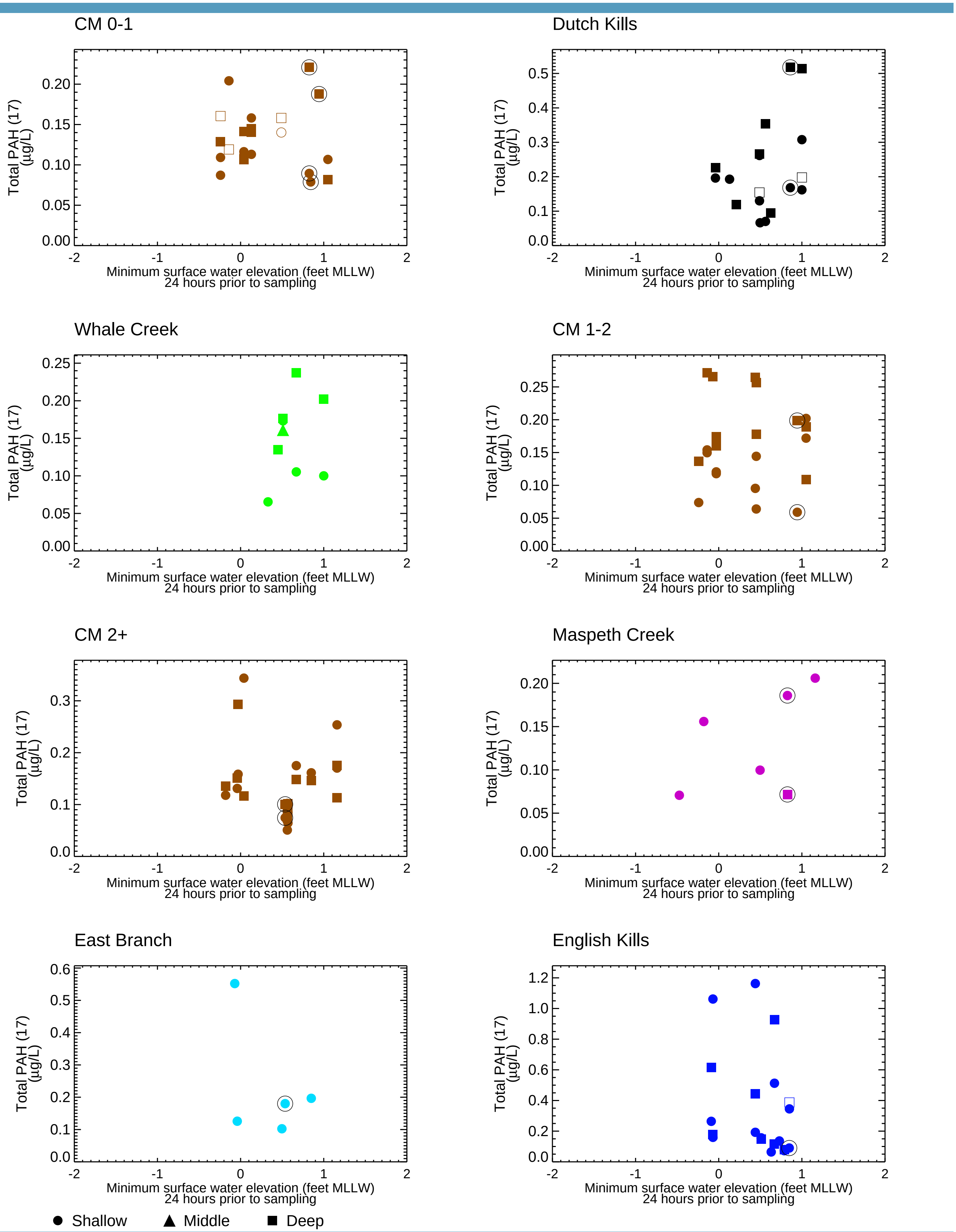

Figure D4-13a

Total PAH (17) in Surface Water During Dry Weather Sampling Events versus Minimum Tide Height 24 Hours Prior to Collection - Samples Collected June through September
Gas Ebullition Evaluation
Newtown Creek RI/FS

ANCHOR QEA

Notes: Non-detects set to the MDL and plotted with open symbol. Totals reported using Kaplan-Meier, if applicable. Samples collected during Phase 2 identified with a halo around symbol. Phase 1 samples collected in June through September 2012. Phase 2 samples collected in August 2014. Shallow samples collected within 3 feet of water surface, middle samples from midpoint of water depth, and deep samples collected within 3 feet of sediment surface. MLLW: mean lower low water.

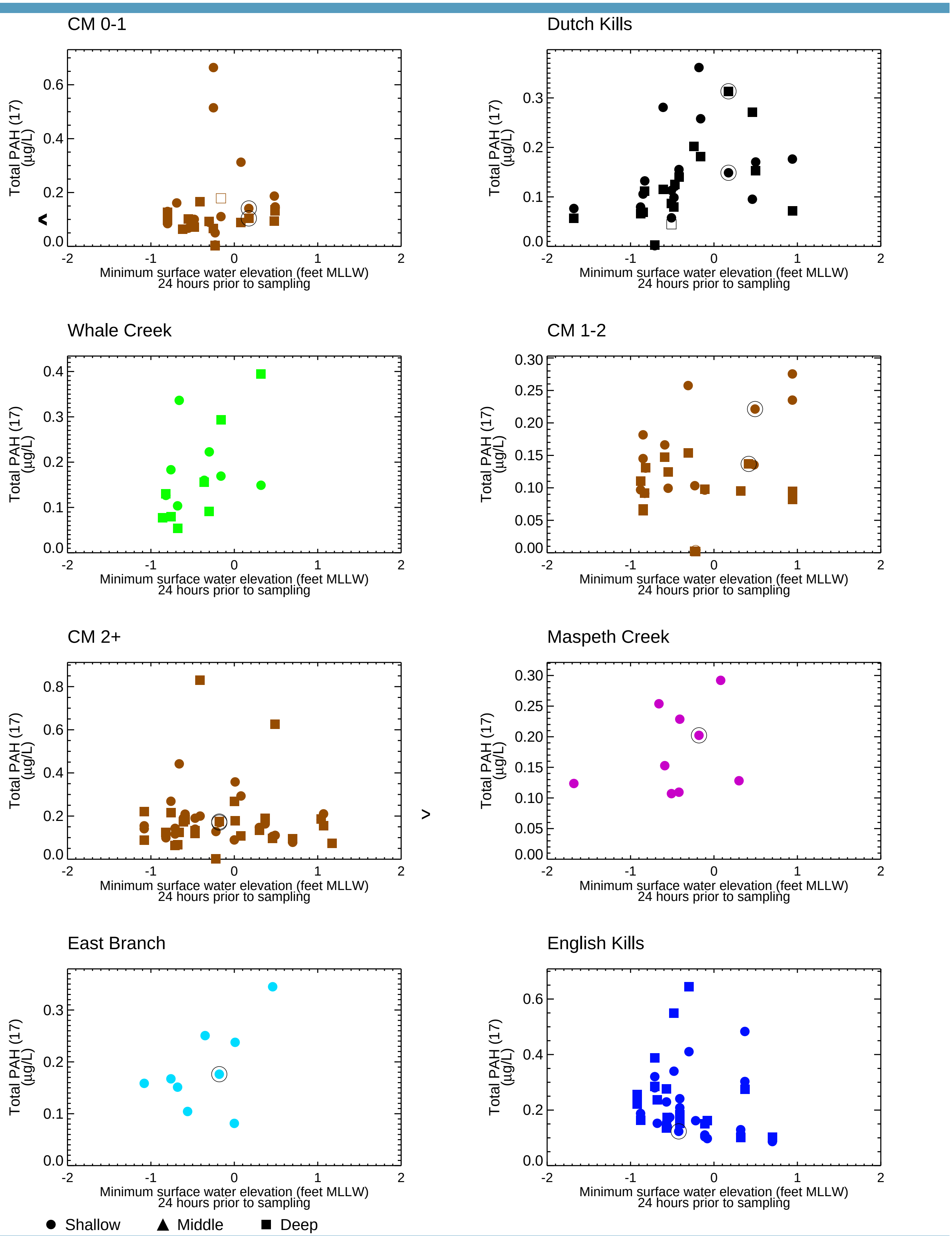

Figure D4-13b

Total PAH (17) in Surface Water During Dry Weather Sampling Events versus Minimum Tide Height 24 Hours Prior to Collection - Samples Collected October through May
Gas Ebullition Evaluation
Newtown Creek RI/FS

Notes: Non-detects set to the MDL and plotted with open symbol. Totals reported using Kaplan-Meier, if applicable. Samples collected during Phase 2 identified with a halo around symbol. Phase 1 samples collected in February through May 2012, October 2012 through January 2013. Phase 2 samples collected in May 2014. Shallow samples collected within 3 feet of water surface, middle samples from midpoint of water depth, and deep samples collected within 3 feet of sediment surface. MLLW: mean lower low water.

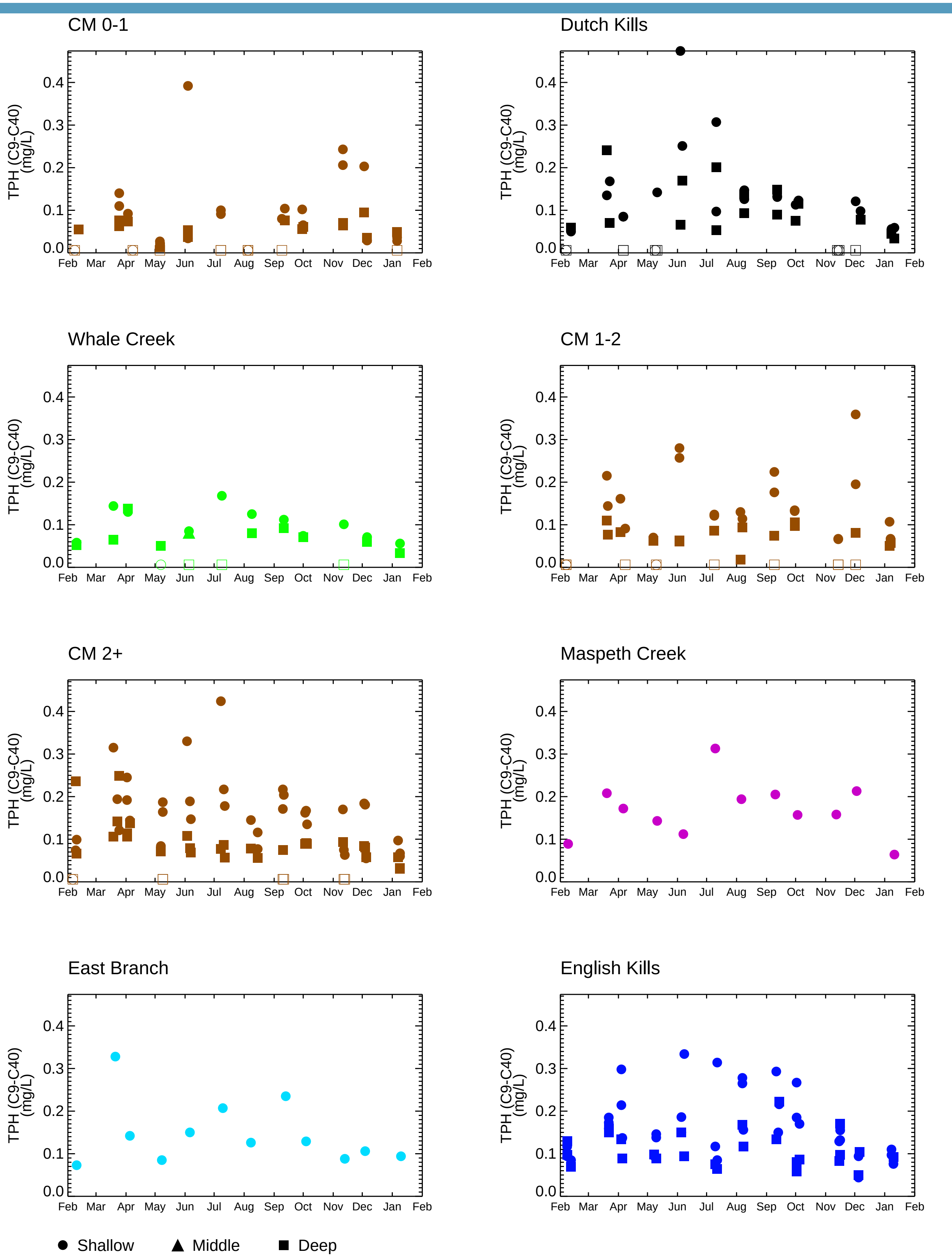

Figure D4-14

TPH (C9-C40) in Surface Water During Dry Weather Sampling Events - Temporal Plots
Gas Ebullition Evaluation
Newtown Creek RI/FS

ANCHOR QEA

Notes: Non-detects set to the MDL and plotted with open symbol. Caret symbols above or below panel indicate the number of values outside y-axis range. Phase 1 samples collected in February 2012 to January 2013. TPH was not analyzed in dry weather samples collected in Phase 2. Shallow samples collected within 3 feet of water surface, middle samples collected from midpoint of water depth, and deep samples collected within three 3 of sediment surface.

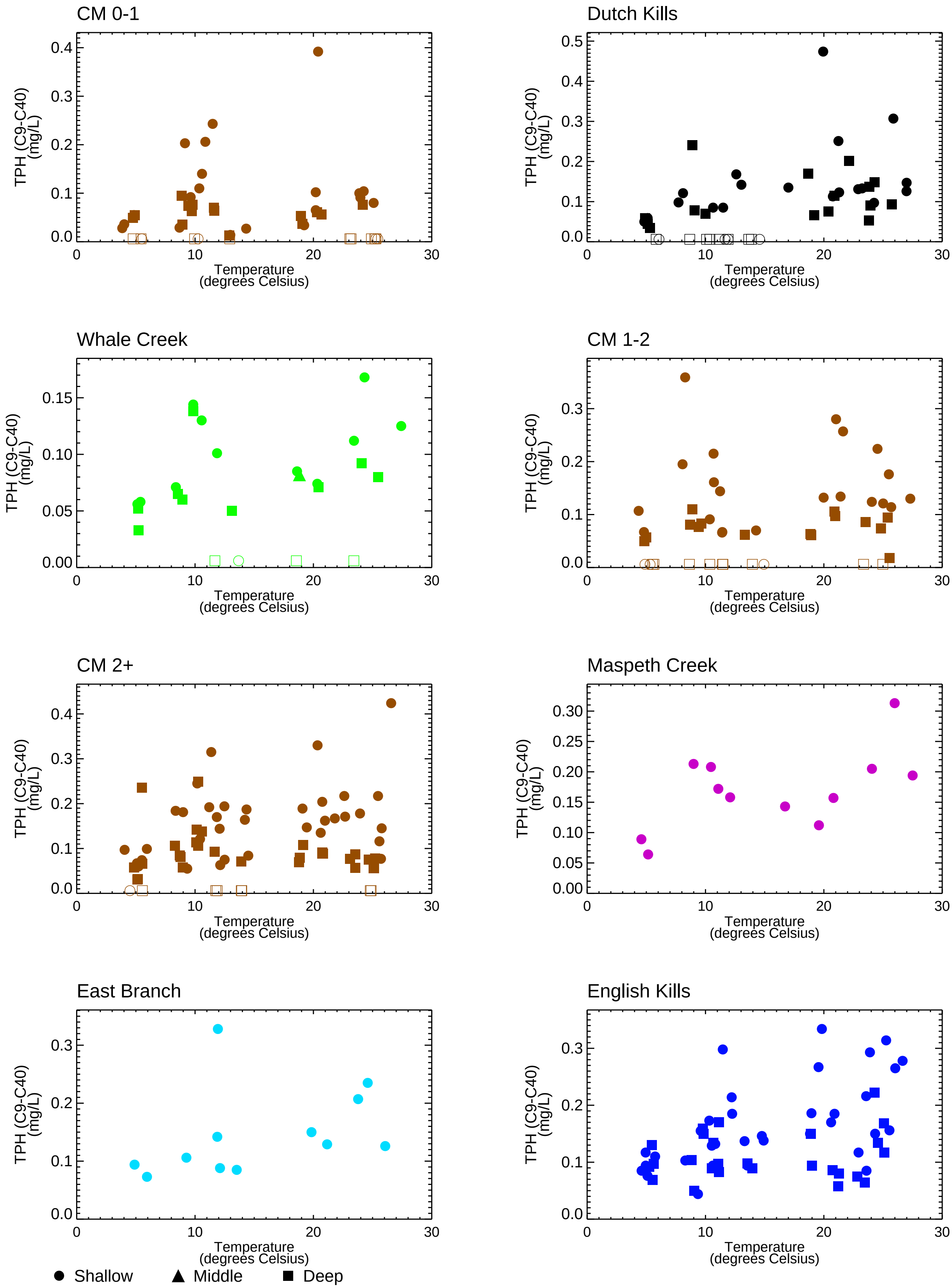

Figure D4-15

TPH (C9-C40) in Surface Water During Dry Weather Sampling Events
versus Surface Water Temperature
Gas Ebullition Evaluation
Newtown Creek RI/FS

Notes: Non-detects set to the MDL and plotted with open symbol. TPH was not analyzed in dry weather samples collected in Phase 2. Shallow samples collected within 3 feet of water surface, middle samples from midpoint of water depth, and deep samples collected within 3 feet of sediment surface.

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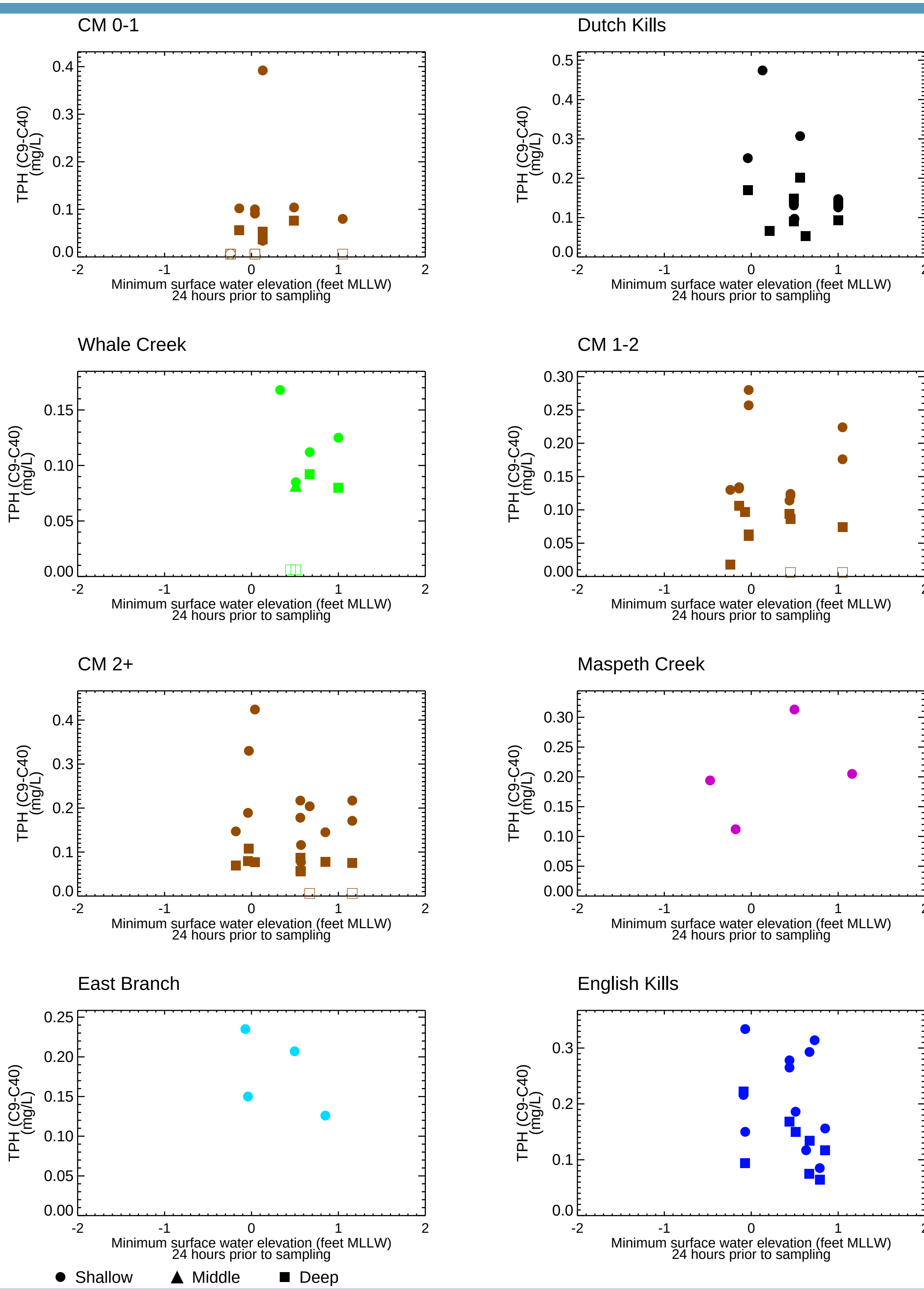

Figure D4-16a

TPH (C9-C40) in Surface Water During Dry Weather Sampling Events versus Minimum Tide Height 24 Hours Prior to Collection - Samples Collected June through September

Gas Ebullition Evaluation

Newtown Creek RI/FS

ANCHOR QEA

Notes: Non-detects set to the MDL and plotted with open symbol. TPH was not analyzed in dry weather samples collected in Phase 2. Phase 1 samples collected in June through September 2012. Shallow samples collected within 3 feet of water surface, middle samples from midpoint of water depth, and deep samples collected within 3 feet of sediment surface. MLLW: mean lower low water.

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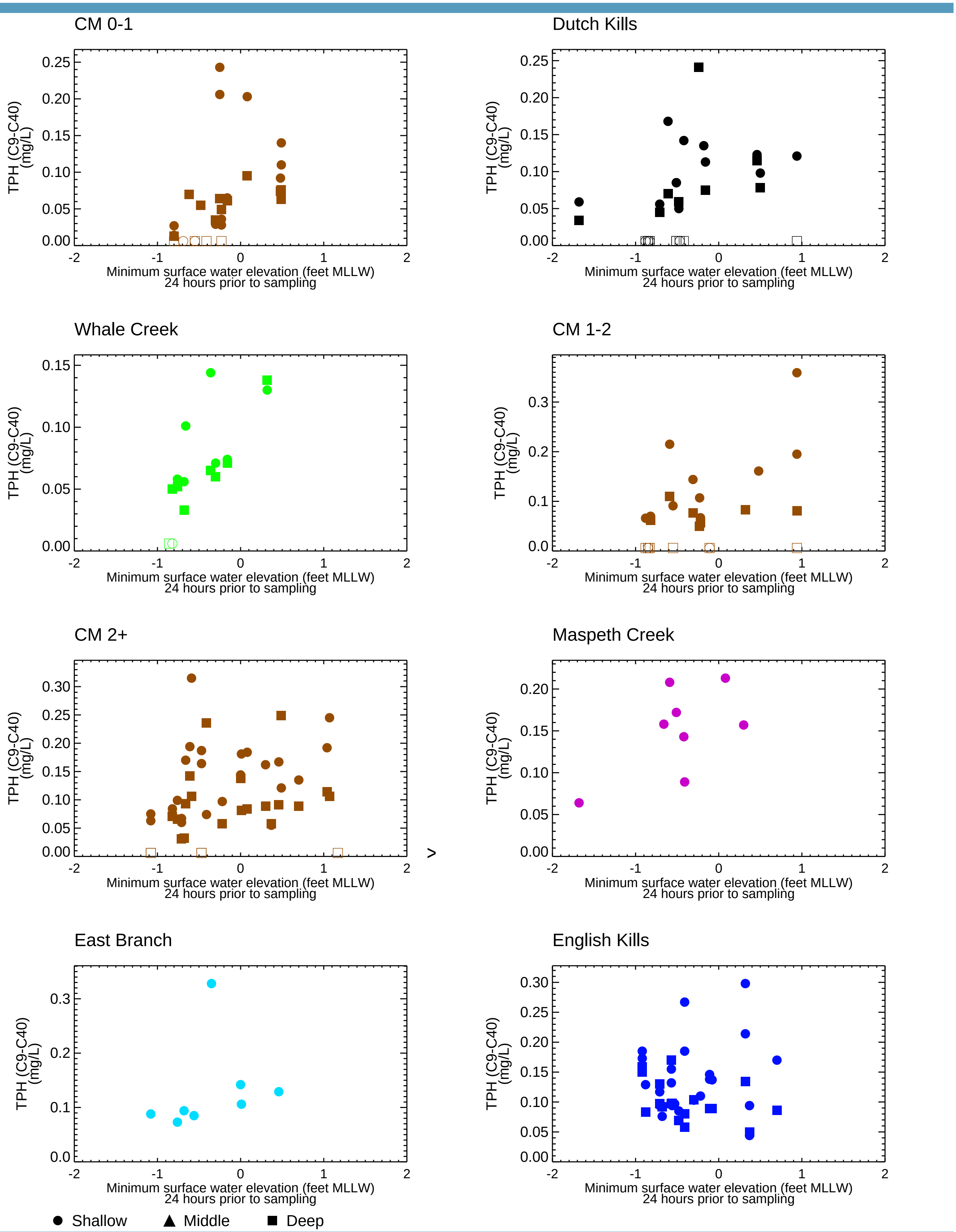

Figure D4-16b

TPH (C9-C40) in Surface Water During Dry Weather Sampling Events versus Minimum Tide Height 24 Hours Prior to Collection - Samples Collected October through May
Gas Ebullition Evaluation
Newtown Creek RI/FS

Notes: Non-detects set to the MDL and plotted with open symbol. TPH was not analyzed in dry weather samples collected in Phase 2. Phase 1 samples collected in February through May 2012, October 2012 through January 2013. Shallow samples collected within 3 feet of water surface, middle samples from midpoint of water depth, and deep samples collected within 3 feet of sediment surface. MLLW: mean lower low water.

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